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THE UNIVERSITY OF ALBERTA

# RATED WORD AROUSAL AS AN ENCODING DIMENSION IN SHORT TERM MEMORY

by

© ALLAN W. HAYDUK

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Rated Word Arousal as an Encoding Dimension in Short Term Memory

submitted by Allan W. Hayduk

in partial fulfilment of the requirements for the degree of Master of Education.

John Osborne
Supervisor

Date July 18, 1975

## ABSTRACT

This study employed the Wickens, Born, and Allen (1963) release from proactive interference experimental paradigm. A significant amount of release from proactive interference was obtained by shifting between differentially arousing categories of words, and this finding suggested that rated word arousal is an encoding dimension in short term memory. The stimulus words were then rated by a semantic differential type procedure of the Osgood, Suci, and Tannenbaum (1957) variety and the two arousal categories were found to differ on the Activity, Potency, and Evaluation factors. It was suggested that the meaning component of the rated word arousal encoding dimension may consist of a specific psychological sensitivity within subjects to a pattern of non-polar variation within Osgood's three-dimensional semantic space.

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TABLE OF CONTENTS


| | Page |
|---|---|
| Abstract | iv |
| Acknowledgements | v |
| List of Tables | viii |
| List of Figures | ix |
| Chapter I: Introduction | 1 |
| Overview | 1 |
| Introduction | 2 |
| Release From Proactive Interference | 3 |
| Motivation, Arousal and Memory | 6 |
| Rated Word Arousal | 9 |
| Arousal: An Encoding Class? | 10 |
| Predictions | 13 |
| Arousal: Some Complicating Problems | 13 |
| Problem one | 14 |
| Problem two | 16 |
| The Secondary Hypotheses | 19 |
| Summary | 21 |
| Chapter II: Method | 22 |
| Subjects | 22 |
| Materials | 22 |
| Procedure | 23 |
| Design | 25 |
| Chapter III: Results and Discussion | 28 |
| The Secondary Hypotheses and the STM Experiment | 28 |
| The Short Term Memory Experiment | 32 |

TABLE OF CONTENTS (continued):


| | Page |
|---|---|
| Results | 32 |
| Discussion | 34 |
| The Rated Words: Some Specific Considerations | 37 |
| The Long Term Memory Experiment | 49 |
| Summary | 55 |
| References | 57 |
| Appendices | 60 |

LIST OF TABLES

Page

Table 1 Means and Differences of the Arousal, Evaluation, Activity, and Potency Components of the Two Arousal Categories..... 39

## LIST OF FIGURES


Page

Figure 1 An example case of release from PI in which the experimental subjects were shifted between classes of numbers and letters while the control subjects were not (After Wickens, 1972)..... 4

Figure 2 Schematic representation of the method for quantifying release from PI, given by X/Y x 100 (After Wickens, 1972)..... 27

Figure 3 Percent recall from short term memory by the two control groups and the two shift groups..... 29

Figure 4 Percent recall from short term memory by the combined control group and shift group..... 33

Figure 5 Percent recall from long term memory of the high arousal control group and the high to low arousal shift group..... 51

Figure 6 Percent recall from long term memory of the combined control and shift groups..... 53

# CHAPTER I

## INTRODUCTION

### Overview

The primary purpose of this study was to investigate rated word arousal as an encoding dimension in short term memory (STM) by using a release from proactive interference (PI) experimental technique of the Wickens, Born, and Allen (1963) variety. All subjects were presented with four sequential word triad slides after each of which they were required to recite the words, perform a counting backwards task, and then attempt to recall the words. The word triads were drawn either from a specified range low in the rated word arousal dimension (low arousal words) or from a different range higher in the same scale (high arousal words). Control groups saw words from either one or the other of these ranges, but not both. Experimental (shift) groups saw the first three slides in the sequence from one range and the final slide from the other range. In an argument parallel to that advanced by Wickens (1970), if PI was built up over the first three trials of the experimental groups and was then released by the presentation of words from the other range, then the two ranges could be considered as different classes and rated word arousal could be considered as an encoding dimension in STM.

A secondary purpose of this study was to examine the recall from long term memory (LTM) of those items which had been presented to the subjects in the initial part of the STM experiment. Although the LTM

component of this study was initially intended to serve as a control and verification mechanism for some aspects of the STM encoding experiment, it became apparent that it could serve independently as an interesting area of study. To this end LTM recall data were collected from the subjects twenty-four hours after the initial performance in the experiment.

This chapter begins with a description and discussion of the release from proactive interference experimental design. The specific use of this experimental technique to identify and measure encoding dimensions in short term memory is discussed. The state of motivation theory in general and of arousal theory in particular is discussed next, followed by a review of the changing nature of the concept of arousal. Rated word arousal is identified as a dimensional component of arousal and proposed as an encoding dimension in STM. Some specific complicating problems are identified, and specific solutions are proposed. The theoretical limitations of using rated word arousal and the possibilities of extending this research to include psychophysical and ecological arousal variables are considered. The chapter closes with a restatement of the purpose of the study and the listing of specific predictions to be tested.

## Introduction

Bower (1967) proposed a multi-component theory of memory in which he postulated that incoming environmental information would be subject to multiple encoding according to its conceptual psychological dimensions. Similarly, Underwood (1969) conceptualized memory as a multi-dimensional collection of attributes which would serve in the encoding of words to discriminate one memorial event from another

and in the recall of words both as a target memory and as a retrieval mechanism. Further, Underwood (1969) divided the attributes of memory into two broad classes: Task independent which included temporal, spatial, and frequency components; and task dependent which included modality, orthographic, associative verbal, and associative nonverbal components. Wickens (1972) reported a series of 21 studies, primarily involving task dependent attributes, which investigated the dimensions along which words are encoded in short term memory. Consistent with a multi-component theory of memory, each of the studies identified a separate specific STM encoding attribute.

Release From Proactive Interference

Studies of the variety reported by Wickens (1970, 1972) have been undertaken by using the release from PI experimental technique in STM. (Essentially PI means that the learning of items at the beginning of a list interferes with the recall of items learned later in the same list.) Procedurally this technique, as it was refined by Wickens, Born, and Allen (1963) commences with "the presentation of a triad of words that may be considered to be members of a common class" (Wickens, 1972) after which:

> [A] rehearsal preventative or distractor task follows for 20 seconds; a recall is requested; 30 seconds after an item has been presented another item of the same class follows and so on for three trials. The control group continues in the same fashion on the fourth trial; but for the experimental group, the fourth-trial triad consists of material drawn from some different class. . . . All items are presented by means of a carousel projector using a vertical array. (p. 194)

Typically, when release from PI is obtained, the results to some extent resemble those shown in Figure 1. In the example case of Figure 1 all subjects would have seen spelled out number triads (e.g., two, six,

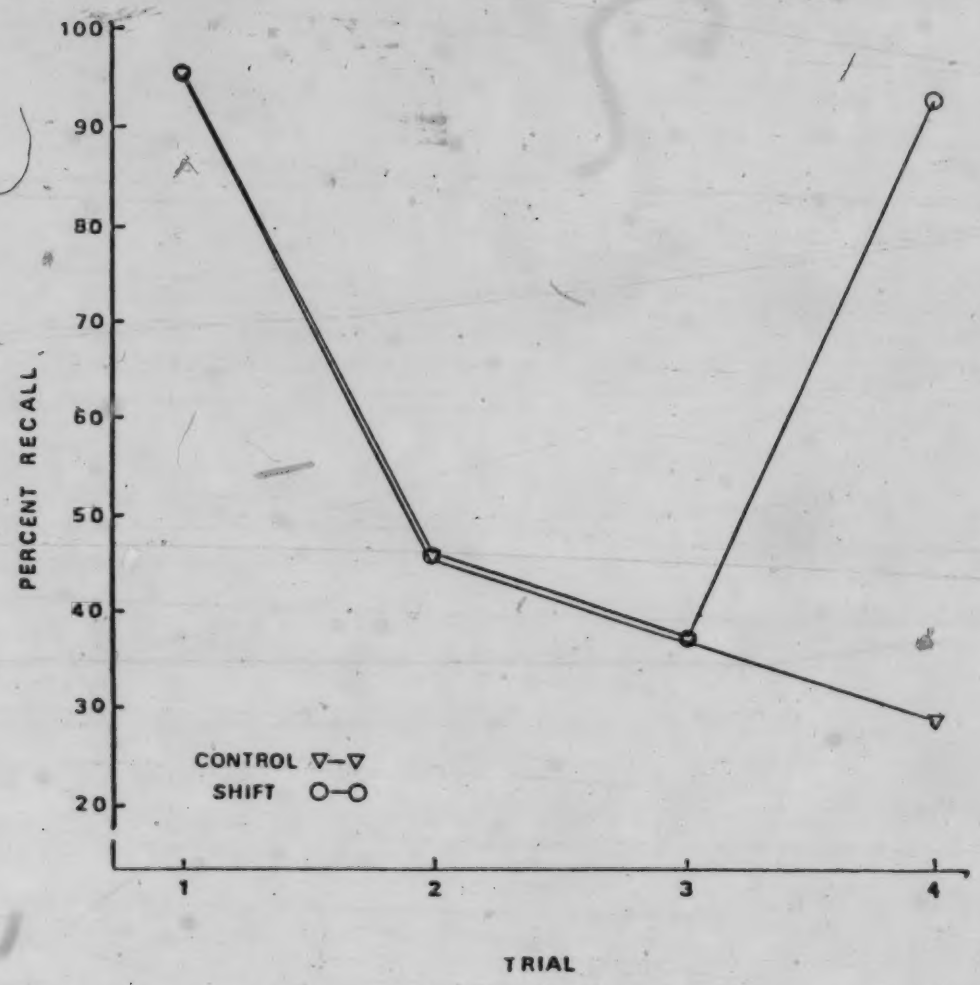


Figure 1 An example case of release from PI in which the experimental subjects were shifted between classes of numbers and letters while the control subjects were not (After Wickens, 1972)

four) on trials one, two, and three. On trial four, the control group would have seen another number triad, while the shift (experimental) group would have seen a triad of non-number words (e.g., book, chair, doctor). The experiment would usually be run both ways. In this instance, for example, as many subjects would proceed from numbers to non-numbers as would proceed from non-numbers to numbers. Not all release from PI research has followed this design exactly. Probably one would be most correct to regard the basic procedure as an experimental theme upon which many design variations appropriate to the subjects and to the materials at hand have been made (cf. Wickens, 1970, 1972; Johansson, Lindberg, & Svensson, 1974).

Historically, this technique, which has become basic to much STM research, was first described by Peterson and Peterson (1959) in a study in which they used a distractor technique in an effort to extend the study of interference theory in LTM into STM with single items. Keppel and Underwood (1962) reanalyzed the Peterson and Peterson research in such a way as to lend empirical support to that extension. In doing so, they showed that the Petersons had failed to identify PI effects due to procedural difficulties in their work. The Wickens, Born and Allen (1963) experimental design outlined above is a slight modification of the original Peterson and Peterson technique. It has been used repeatedly (cf. Wickens et al., 1963; Loess, 1967; Wickens, 1970, 1972) to show that PI buildup is specific to the class of material being presented and that release is obtained from PI by shifting the class of the material presented.

Release from PI is assumed to occur because the shift (release) triad is encoded differently than are the first three triads (Wickens,

1970). As a result, the shift (release) triad is not as subject to the PI that has accumulated over the first three trials. The occurrence of a significant release from PI has commonly been accepted as evidence that the dimension under consideration functions as an encoding dimension in short term memory (Wickens, 1972). In addition, the amount of release from PI has been interpreted as a measure of the psychological distinctiveness of the encoding classes in that the more psychologically dissimilar the classes are, the less they will interfere with each other and the greater will be the release (Kroll, Bee, & Gurski, 1973; Wickens, 1970). It is the ability of the Wickens, Born, and Allen procedure either to identify and quantify, or to reject specific psychological categories as encoding dimensions that has led to its adoption as a basic tool in the study of STM.

Motivation, Arousal, and Memory

The notion that motivation can affect retention has been extensively studied (Weiner, 1966; Rapaport, 1942; Berlyne, 1967). Unfortunately, the multiplicity of motivational theories (cf. Cofer, & Appley, 1967; Berlyne, 1967), the fragmented nature of much of the research, and the equivocal nature of many of the studies (cf. Weiner, 1966; Berlyne, 1967) appears to preclude a clear statement of the specific relationship between motivation and retention. In a comprehensive review Weiner (1966) concluded that in spite of these shortcomings and other more specific methodological weaknesses there exists substantial evidence that memory is in fact influenced by motivation.

Arousal, traditionally regarded as a motivational variable, has been found to influence memory, although there is not general agreement

on how it does so (Weiner, 1966; Berlyne, 1967). The preponderance of the evidence suggests that higher levels of arousal facilitate long term retention (Osborne, 1971; Berlyne, 1967). That arousal affects short term recall has been well established, but the directionality of the effect remains unclear. Osborne (1971) in a review of this question concluded that the weight of the evidence indicates that arousal facilitates short term retention but that considerable evidence to the contrary also exists. In addition, some studies have shown arousal to have no effect upon short term retention (Berlyne, Borsa, Craw, Gelman, & Mandell, 1965). The unclear nature of the relationship between arousal and memory appears partly to reflect the confused state of the relationship between motivation and memory in general. Some lack of clarity is introduced, however, by a series of changes in the concept of arousal which have taken place during the last fifteen years.

Early conceptions of arousal were excessively simplified in that arousal was regarded as a single continuum ranging from sleep to high excitement (cf. Berlyne, 1966, 1967). From this perspective arousal level varied directly with the amount of neural activity in the reticular activation system of the brain stem. The continuum approach meant that levels of arousal could be obtained either by directly measuring the activity occurring in the reticular activation system or by measuring the physiological correlates of arousal which included changes in circulatory and respiratory activity, muscle tension, skin conductance properties and other similar observable responses.

From much of the research done in the late 1950s and early 1960s it became apparent that measures of these physiological correlates did

not correlate highly with one another (Berlyne, 1967). Further, these physiological correlates did not appear to depend solely on neural activity in the reticular activation systen (Berlyne, 1967). Lacey (1967) considered this problem and concluded that there are at least three functionally and anatomically separable kinds of arousal including autonomic, behavioural, and electrocortical arousal. Because this conclusion was incompatible with the conception of arousal as a single continuum type of phenomenon, it became necessary to modify the concept of arousal.

Berlyne (1967) has suggested that arousal be regarded as a dimension instead of a phenomenon. From this perspective arousal would no longer be identified as a single specific process found in one location in the central nervous system. Instead, a specific measure of arousal level would be conceptualized as providing only some, but not complete, information about the psychophysiological state of the organism. More complete psychophysiological information could be obtained only by considering the effect on the organism of other dimensions, including, if necessary, other measures of arousal (Berlyne, 1967).

A large number of measures of arousal level have been developed and used in arousal, verbal learning, and memory research (cf. Cofer, & Appley, 1964; Berlyne, 1967). Psychophysical arousal variables, which normally occur in response to changes in stimulus intensity, are customarily measured as degrees of change on such physical measures as blood pressure, respiration rate, frequency of eye blink, palmar conductance, GSR, desynchronization of EEG, decreased proportion and amplitude of alpha waves, self-ratings of arousal, and so on.

Ecological (survival related) arousal variables are usually measured as internal visceral and hormonal changes that occur in response to food, water, and sex deprivation, as well as to fear or anger. Collative arousal variables occur in response to novelty, surprise, or ambiguity and have been measured by many of the above indices (cf. Berlyne, 1966). If arousal is regarded as a dimension, as suggested above, then neither the fact that poor correlations exist between most of these measures, nor the fact that the arousal they measure is in response to different determinants appears to be of undue concern to most researchers (cf. Berlyne, 1967).

Rated Word Arousal

Words which have been rated on an a priori basis as differentially arousing have been used as arousal determinants in a number of arousal and memory studies (Osborne, 1972; Osborne, 1973; Maltzman, Kantor, & Langdon, 1966; Kleinsmith & Kaplan, 1963, 1964; Walker, & Tarte, 1963). Walker and Tarte (1963) for example, used high arousal stimulus words such as money, rape, embrace, vomit, and passion; and low arousal stimulus words such as white, pond, berry, and flower. Although such an approach is consistent with a dimensional conception of arousal, it should be noted that the use of rated words as arousal determinants essentially constitutes an operational definition of arousal and represents a departure from the physiological perspective.

McNulty and Noseworthy (1966) have suggested that individuals may channel their arousal through specific modalities so that the physiological indices being monitored in a study may or may not be valid measures of the subjects level of arousal. Such a condition could create an inter-subject fluctuation of the effect of arousal on

retention particularly if the method of channeling included differential involvement of encoding and memorial mechanisms. It would seem reasonable to suggest that the use of rated words as arousal determinants could provide a more consistent and uniform change in the study of arousal level on memory than many of the ecological and psychophysical arousal determinants. This suggestion is speculative and is based on the undemonstrated assumption that because the arousal features of a word could only become apparent to the subject during the encoding process, there would be little chance of the arousal being channeled away into some other modality before it made its impact on the encoding mechanism.

Osborne (1973) has established a connection between rated word arousal and autonomic arousal. In a study of the relationships between extroversion, neuroticism, and rated word arousal, he showed that high neurotics rated high arousal words as more arousing than low neurotics did and that extroverts rated low arousal words as more arousing than introverts did. The finding that high arousal words were associated with neuroticism but not extroversion, coupled with the fact that extroversion is a known correlate of cortical arousal, led Osborne (1973) to conclude that rated word arousal is primarily an index of autonomic arousal but not of cortical arousal. This conclusion is fully consistent with the acceptance of rated word arousal as an arousal determinant within the dimension of arousal.

Arousal: An Encoding Class?

That arousal affects memory appears to have been established, although, as previously discussed, there does not seem to be general agreement on how it does so. Arousal, for example, could function

directly as a specific operational component in the learning and/or recall mechanisms, or it could function as a specific or generalized drive component or, to differing degrees, it could function in both capacities.

Berlyne (1967) has suggested that if arousal functions as a drive component, it may do so in three possible ways. First, it could increase the overall activity level of the organism and indiscriminately strengthen the performance of any response that happened to be evoked, instigated, or in progress. Second, it could trigger a specific class of learned or innate behaviour so that class specific results would follow a specific arousal determinant. Third, it could function as a reinforcer and hence serve to strengthen responses in progress at the time. These possibilities are not considered as mutually exclusive, so that to some differing extent all three functions could be activated by the same change in arousal level.

There appears to be uncertainty as to whether the effects of arousal and other motivational factors reflect the degree of original learning, the degree of retention, or the degree of subsequent recall (Weiner, 1966; Underwood, 1964). Indeed, many studies have failed to make these distinctions, in that motivational components were manipulated at the time of the stimulus presentation followed by measurement of the degree of stimulus recall (Weiner, 1966). Other studies have manipulated the arousal variable only during retrieval (Weiner, 1966). Without the experimental separation of learning and retention the two variables become confounded. As a result no definitive conclusions can be drawn about the relationships between arousal and learning, and between arousal and recall (Weiner, 1966).

It should be noted that some researchers, such as Underwood (1964), have maintained that it is impossible to determine whether motivation affects retention directly or indirectly through its influence on learning.

The identification of a specific relationship between arousal and learning, or between arousal and recall, would help to clarify a number of the uncertainties discussed above. For example, if arousal were found to function strongly as a learning or encoding variable, Berlyne's (1967) suggestion that arousal can function by triggering a specific class of learned or innate behaviour would be supported. Such a finding would neither counter nor weaken the concept of arousal as a non-specific and indiscriminate motivational variable, in that if arousal is a bonafide psychophysical variable, then high arousal words could have a non-specific, activity increasing, performance strengthening function as well as a specific learning or encoding function.

The identification of arousal as a learning variable would suggest a re-evaluation of many of the studies which have failed to make the distinction between learning and recall components. In many of these cases more post hoc emphasis could be placed upon learning and less upon recall mechanisms. Such a re-evaluation could help to clarify further the relationship between arousal and memory.

The primary purpose of this study was to investigate rated word arousal as an encoding dimension in STM by using a release from PI experimental design of the Wickens, Born, and Allen (1963) variety. The rationale for such a study was suggested directly by the literature.

Osgood, Suci, and Tannenbaum (1957) constructed a semantic differential which described the characteristics of Evaluation,

Potency, and Activity as the three dimensions in a three-dimensional verbal space. Wickens and Clark (1968) conducted three release from PI experiments using words from the extremes of each of these three Osgood semantic differential scales. For each of the scales a large amount of release from PI was obtained, and it was concluded that each of the three dimensions functions as a verbal encoding attribute in STM. Osborne and Frankiewicz (1972) in a factor analytic study of high and low arousal words suggested that arousal is partly subsumed by Osgood's Activity factor. This would clearly suggest that release from PI could be obtained by manipulating rated word arousal as an encoding dimension in STM.

Predictions

Consistent with, and arising out of, the foregoing discussion it is hypothesized that the release from PI experimental technique can be used to demonstrate that arousal is a dimension along which words are encoded in STM. This may also be stated in subforms directly amenable to statistical testing. i.e., (1) A shift from high arousal to low arousal words will produce a significant release from PI. (2) A shift from low arousal to high arousal words will produce a significant release from PI. These two testable hypotheses represent the primary focus of the study. Unfortunately, some considerable complications, to be discussed in the next section, necessitate the introduction of a number of subsequent hypotheses whose purpose is to ensure uncontaminated data. They are of secondary interest to the study, and as such are titled the secondary hypotheses.

Arousal: Some Complicating Problems

The proposal to use a release from PI design to study arousal as

a word attribute entailed some major difficulties which had not previously arisen in any of the reported release from PI studies. These difficulties were considerable and arose directly out of the nature of arousal theory. The primary difficulty may best be identified by considering Walker's (1958) "action decrement" theory of memory as summarized by Walker and Tarte (1963):

> (1) The occurrence of any psychological event, such as an effort to learn an item of a paired-associate list, sets up an active perseverative trace process which persists for a considerable period of time. (2) The perseverative process has two important dynamic characteristics: (a) permanent memory is laid down during this active phase in a gradual fashion: (b) during the active period, there is a degree of temporary inhibition of recall, i.e., action decrement (this negative bias against repetition serves to protect the consolidating trace against disruption). (3) High-arousal during the associative process will result in a more intensely active trace process. The more intense activity will result in greater ultimate memory but greater temporary inhibition against recall (p. 113).

Problem one. This theory would predict that observed stimulus items with very high arousal levels would be temporarily unavailable for recall from STM even though they continued to exist in STM as some form of consolidating trace, and even though they eventually go on to become strong memories in LTM. Such a phenomenon has been demonstrated by Walker and Tarte (1963) who used such high arousal stimulus items as rape, slut, vomit, passion, money, and sex, and by Kleinsmith and Kaplan (1963) who did the original study using the high arousal items kiss, rape, vomit, exam, dance, money, love. An implication of consolidation theory is that non-specific neural activity can act to support a reverberating trace (Osborne, 1971). It would seem reasonable to suggest that the successive introduction of high arousal stimuli into an experimental stiuation would create both an increasing total amount

of intense consolidating activity, and an increasing amount of non-specific neural activity. The result of such a situation would be a progressive decrement in word stimulus recall as the experiment proceeded. Because such a curve would be similar to that generated by PI, it would seem necessary to unconfound the "action decrement" curve from the PI curve in order to clearly observe the exact amount of release from PI after a class shift.

It is suggested that three specific procedures, two a priori and one post hoc, may be invoked to unconfound the PI and "action decrement" curves without substantially damaging the release from PI experimental design as a test instrument.

The first a priori procedure was to select words which had been used in other studies of arousal, but which were not at the extreme high end of the arousal scale. It seems intuitively obvious that such words would produce less non-specific neural activity than either the Walker and Tarte (1963) words such as rape, slut, and vomit, or excrement and sex act words of the four-letter variety. Of course, a possible objection to such a procedure could be that use of only part of the full arousal range could lessen the amount of the hypothesized release from PI. Such an objection could be largely countered by: (a) showing that the selected words had functioned well in other arousal studies, or (b) by interpreting the Wickens and Clark (1968) suggestion that the release from PI technique is "sensitive to psychological structures within the individual which he himself does not readily recognize" (p. 583) to mean that a selected word stimulus need not be so arousing as to be obvious in order to activate the hypothesized psychological encoding structure, or (c) both of (a) and (b).

The second a priori procedure, which could also be used as a post hoc check on the first, is based on the "action decrement" (Walker and Tarte, 1963) notion that the intense ongoing consolidation activity produced as a consequence of high arousal conditions (what we are trying to isolate) will result in much greater ultimate long term memory. This effect has been demonstrated (Walker and Tarte, 1963; Kleinsmith and Kaplan, 1963). It would seem reasonable to have all subjects who take part in the release from PI study subsequently do a free recall-type of LTM task after twenty-four hours. The information from this LTM task could then be used to graph a possible incremental LTM recall curve, the inverse of which should be very close to the STM "action decrement" curve. If no such curve was found in LTM, it would seem reasonable to believe that the first a priori procedure of non-extreme word selection had been successful in minimizing extreme non-specific neural activity.

If it was found to be necessary (i.e., if a high arousal incremental LTM recall curve was found) it should be possible on a post hoc basis to add the "action decrement" curve information to the untreated experimental data to obtain a much closer approximation to the "real" PI curve. The amount of error thus introduced would vary depending on amount of incremental LTM recall found, if any. The limits of the range of introduced error would also, of course, depend on the amount of PI obtained, if any.

Problem two. A second, and somewhat similar, difficulty would seem possible in the experimental group which undergoes a shift from a series of triads of high arousal words to a triad of low arousal words. In this STM situation, however, it is unclear if residual non-

specific neural activity would facilitate or inhibit the recall of subsequently presented low arousal material. Osborne (1971) in a well-documented review of the effect of arousal on short term retention has indicated that "In spite of [a] weight of evidence indicating that arousal facilitates short term retention considerable evidence to the contrary also exists." For two reasons it would appear unlikely that an excess buildup of non-specific neural activity would significantly affect the results of the proposed study. First, the specific high arousal stimulus words have been selected so as to prevent excess non-specific neural activity. If the words function as intended and no "action decrement" curve (as discussed previously) materializes, then clearly no excess non-specific activity could have been present to affect the release triad. Second, the low arousal triad is preceeded by only three high arousal triads which is probably too small a number to build up sufficient neural reverberation to affect material of a different class. (Note: In this instance stipulating that high and low arousal are different classes is <u>not</u> begging the question in that, if the data were collected and no release from PI was obtained in either direction it would be seen that the materials were of the same class and data analysis would not proceed.)

Once again the LTM situation data can be used to evaluate the validity of the previous theoretical STM arguments. If sufficient non-specific neural activity to either facilitate or suppress STM response availability were present then neural consolidation theory would predict that long term recall of the terminal (i.e., shift) low arousal level triad should be significantly facilitated. This could be checked by comparing the percentage of correct LTM free recall responses of the

experimental low arousal triad group with the LTM free recall of the low arousal control (i.e., non-shift) group as a whole. If (as expected) no significant difference was found, then the problem would have been eliminated by the stimulus word choices. If a significant difference was found, it would become possible to determine whether a suppression, or a facilitation effect had occurred from the direction of the significance. The amount of suppression or facilitation could be found by comparing the overall amount of release from PI in the high to low direction with the amount in the low to high direction. This is possible because in the 21 studies of PI release reported by Wickens (1972) all the reported shifts (except modality) were symmetrical in both directions.

It should be noted that the problems discussed above are based primarily on the "action decrement" interpretation of the effect of arousal on memory. Although this position has received considerable attention and substantial empirical validation (cf. Kleinsmith, & Kaplan, 1963; Walker, & Tarte, 1963; Berlyne, 1967) there is also a considerable body of evidence which fails to support "action decrement" theory (cf. Berlyne, 1967). However, even if action decrement were found to function in the manner described by Walker and Tarte (1963) the exact nature of the relationship between action decrement and the various indices of arousal, including rated word arousal, would still be subject to some doubt. For example, Osborne's (1973) suggestion that rated word arousal is primarily an index of autonomic rather than of cortical arousal would appear to remove rated word arousal largely from the domain where it would be capable of creating action decrement.

The uncertainty of the situation suggested three possible courses of action. First, if clear evidence of action decrement was observed in the LTM results, the data could be interpreted exactly as discussed above. Second, if no evidence of action decrement was observed in the LTM data, it could serve as a fertile situation in which to investigate the effects of PI and PI release in short term memory on subsequent recall from LTM. The STM situation could be interpreted exactly as discussed above. Third, if minimal, partial, or equivocal evidence of action decrement was observed in LTM then the STM component of the experiment could be interpreted exactly as discussed above but great caution would have to be exercised in any extension or extrapolation of what would essentially be contaminated LTM results.

The Secondary Hypotheses

The potential need for a number of secondary hypotheses has been demonstrated in the above discussion, and verbal equivalents of the hypotheses have been given in the text. In testable form these hypotheses are: (a) In the LTM free recall high arousal control group there is no significant increase in recall between the first and the fourth triad groups. (b) In the LTM free recall high to low experimental group, there is no significant increase in recall between the first and the third triad groups. In the event that (a) above was rejected and in consequence it was found necessary to add the "action decrement" curve data to the release from PI data in order to obtain an approximation to the "real" PI curve; (c) the obtained curve is only to be deemed acceptable if it does not deviate significantly from the low arousal control group PI curve. (d) The percentage of correct LTM free recall in the fourth (shift) triad of the high to low experimental

group is not significantly greater than the LTM free recall of the low arousal control group as a whole.

It must be stated that a potential for similar problems of the variety that necessitated the secondary hypotheses continues to exist. (e.g., the effect of non-specific neural activity on the high arousal experimental shift.) Such problems would be second or third generation type problems each of which would be contingent upon unfavourable results being found in the first generation (a, b, c, d) secondary hypotheses. If such was the case, and if the study was to be continued, it would then become necessary to specify additional hypotheses, the nature of which would depend on the data at hand. Because such a condition appears highly unlikely, and because the stipulation of further hypotheses would be primarily speculative without some in-hand data to establish a direction, no more such hypotheses are stated at this time.

It should also be noted that two specific findings in the STM data, should they occur, could indicate the absence or lack of effect of action decrement. First, if the STM recall curve of the low arousal control group was equal to or lower than the STM recall curve of the high arousal control group, then the temporary inhibition of recall of the high arousal words due to action decrement could be seen not to have occurred. Second, if the recall curves of the two experimental groups did not differ significantly from one another on any trial, it would be apparent that action decrement had not affected the release from PI phenomenon (if any release were found). The joint occurrence of these two conditions, should they occur, would logically preclude the necessity of testing the secondary hypotheses.

In Summary

This chapter began with a description and discussion of the release from proactive interference experimental design. The specific use of this experimental technique to identify and measure encoding dimensions in short term memory was discussed. The state of motivation theory in general and of arousal theory in particular was discussed followed by a consideration of the changing nature of the concept of arousal. Some complicating problems were identified and specific solutions were proposed. Rated word arousal was identified as a dimensional component of arousal and proposed as an encoding dimension in STM. The predictions were stated in testable subforms as: (1) A shift from high arousal to low arousal words produces a significant release from PI; and (2) A shift from low arousal to high arousal words produces a significant release from PI. Although a number of secondary hypotheses were introduced to ensure uncontaminated data, the two hypotheses stated above represent the primary focus of the study.

## CHAPTER II

## METHOD

Subjects. The subjects were 96 male and female University of Alberta undergraduate students from large Educational Psychology courses. All students who participated had a seminar quiz worth two percent of the final course grade waived and were paid $1.00 at the conclusion of the experiment. Two subjects were replaced; one for failure to follow instructions, and one for previously undisclosed memory improvement training. None of the subjects had previously taken part in any psychological experiments.

Materials. Osborne (1973) chose forty nouns from the 925 nouns listed by Pavio, et al. (1968) on the basis that they be equated for mean imagery and frequency, but differ maximally on arousal. These were subsequently rated for arousal on a seven-point scale, using a procedure similar to that of Pavio, et al. (1968), by 218 volunteers from an introductory Educational Psychology course at the University of Alberta (cf. Osborne, 1973). From these 40 nouns the experimenter chose 12 low arousal and 12 high arousal nouns on the basis of maximal discrimination of low and high rated arousal levels and minimum potential for mnemonic association. They were then grouped into triads which the experimenter again chose so as to minimize mnemonic association (e.g., not policeman, handcuffs, jail but policeman, volcano, ghost). Because similarity of word sounds may affect interference or noninterference effects (Conrad, 1964; Wickelgren, 1965), no similar sounding words were included in any

one triad.

All triads were printed in a staggered vertical array (cf. Wickens, 1972) on white cards using black primary type. They were then photographed using a standard 35 mm format and a standard camera to card distance so that all letters would remain the same size upon projection. A number of asterisk, question mark, and randomly selected three-digit number slides were also prepared using the same procedure.

Procedure. All slide sequences were projected with a carousel AV 900 projector which was controlled by a Sony 630 reel to reel tape deck timer. All instructions were video-taped and presented to the subjects on a remote controlled video-tape monitor.

Each subject entered the experimental room and was seated. His personal data was obtained (name, address, phone, year of education), and he was assigned an experiment number. He then viewed a standard set of video-taped instructions (Appendix H) in which he was told that because the experiment was very brief (about six minutes) he would also be asked to take part in a second short experiment at the conclusion of the first. The mechanics of the experimental situation, as well as the performance required of the subject were explained, and the video-tape was stopped. If the subject had any questions, they were answered, and the experiment then began.

All materials were projected on a screen about five feet in front of the subject. An asterisk attention signal appeared for two seconds. It was replaced by the first word triad which appeared for about 1.5 seconds. The subject repeated the words once in order to expose perceptual or processing errors. A three digit number slide appeared, and the subject began immediately to count backwards, by threes, from

the displayed number as rapidly as possible for 15 seconds. The number was replaced by a question mark and the subject had ten seconds to recall as many of the three words as he could remember before the question mark disappeared. After a rest interval of six seconds, an asterisk appeared, for two seconds, as a get ready signal for the second triad. The experiment proceeded thus for three trials during which the subjects saw words from only one arousal category (high or low).

On the fourth trial the experimental group was presented with words from the other category (i.e., The previously low arousal group now saw a high arousal triad and vice versa). An equal number of subjects changed from low arousal words to high arousal words as changed from high arousal words to low arousal words. The control groups saw all four word triads only from within the same category (i.e., either, all low arousal words, or all high arousal words).

After the conclusion of four trials the subject was thanked for having finished the first experiment. A short rest break was taken, and the subject then viewed standard video-taped instructions for the second experiment (Appendix I). It was suggested to the subject that different people have very different emotional reactions to the first type of experiment (as indeed they do) and that the second experiment was designed to measure how people's attitudes toward psychology are changed as a result of having taken part in a psychological experiment. It was explained that, in order for the results to be meaningful, no questions could be asked until after the specific details of the first experiment had a chance to fade away (24 hours). As a result, subjects would be given an attitude change questionnaire to take home and answer in 24 hours. The importance of waiting 24 hours was stressed, and the

subject was asked not to discuss the experiment with anyone until after the 24 hours had elapsed.

Each subject was given a sealed envelope with a return address marked on the front along with his subject number and the time and date the envelope was to be opened. On the back flap of the envelope was marked, "Attitudes to STM Research, Scale C, Group 2." Inside the envelope was a letter (Appendix G) asking for the recall of words from the experiment, explaining briefly why it was necessary to use deception, thanking the subject, and asking him to please note the exact time and date he opened the letter if that deviated from the required time by more than one hour. Each subject left after receiving the envelope.

The actual physical recording of the data for the STM task was done by checking off the appropriate spaces of data collection forms (Appendicies B, C, D, & E) as the subjects verbalized the recalled words. In order to identify subjects who attempted to facilitate word rehearsal by lessening their concentration on the distractor task, both the rate of counting and the number of errors in counting were recorded during each distractor task. The recording of LTM data was done in the appropriate spaces of the same forms as the STM data as the responses were received.

Design. The stimulus words were distributed in all groups by using a counterbalancing rotation system such that each word occurred in each position of each triad an equal number of times throughout the experiment. Each triad occurred in each possible trial position an equal number of times. Because of this rotation system each word occurred in each possible trial position two times during the experiment. In no

case in the second presentation of any given word was the word above or below it in the same position as in the first presentation (cf. Appendix E). Exactly the same procedure was adopted with the high arousal words as with the low arousal words (cf. Appendix D). The low to high experimental (shift) group was made by removing the fourth trial row from the low control group and replacing it with the fourth trial row from the high control group (Appendix B). The high to low experimental (shift) group was made up in a similar fashion (Appendix C).

There were twenty-four subjects in each experimental group and in each control group. All experimental subjects were randomly assigned to experimental positions by picking numbers from a hat. The appropriate control subject was run immediately after each experimental subject (see Appendix F). (i.e., The same fourth trial triad was presented to consecutive subjects.) The distractor task subtraction numbers were counterbalanced so that the same numbers did not appear in the same ordered position throughout the experiment.

As might be expected with such a basic research tool as the release from PI experimental design, a standard method of reporting results has been adopted by many researchers (cf. Wickens, & Clark, 1968; Wickens, 1972). Both experimental groups are combined and then considered as a single experimental group. Similarly, both control groups are combined and then considered as a single control group. The method used to quantify release from PI with the joint groups is given by X/Y x 100 as shown in Figure 2, where X is the difference in percent recall between the experimental and the control groups on the shift trial, and Y is the difference in percent of recall between the first and the final trials of the control group. As discussed in the next chapter, the result is then reported as a percent release from PI.

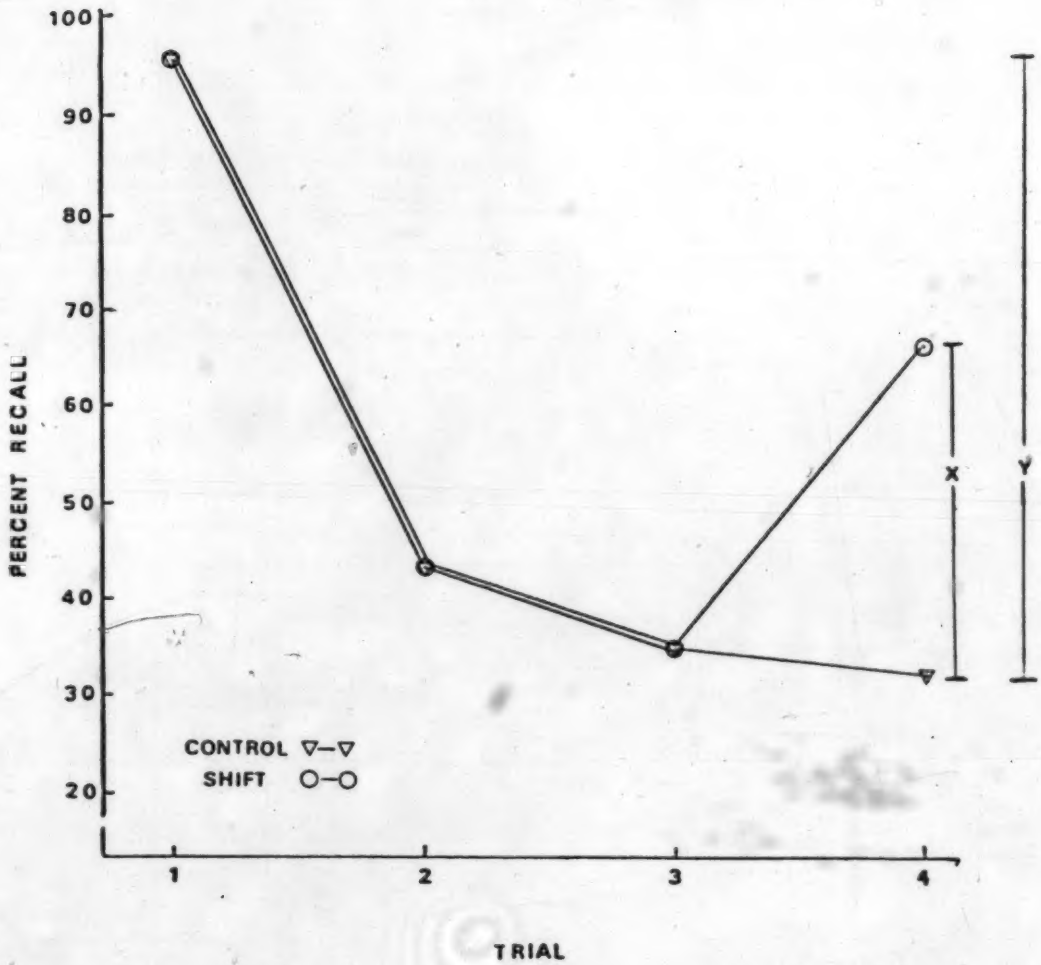


Figure 2 Schematic representation of the method for quantifying release from PI, given by X/Y x 100 (After Wickens, 1972)

# CHAPTER III

## RESULTS AND DISCUSSION

This chapter begins with a discussion of those aspects of the secondary hypotheses which must be considered prior to interpreting the STM results. The STM results are then presented and discussed. This is followed by a discussion of the specific nature of the words used in this study and the effect this factor has on the generalizability of the study as well as some specific implications for other existing arousal studies. The LTM results are then presented and discussed. The chapter closes with a brief summary of the results and conclusions.

### The Secondary Hypotheses and the STM Experiment

The specific nature of the STM data indicated that not all the secondary hypotheses had to be considered prior to interpreting the STM results. It will be recalled that action decrement theory predicts that the intense neurological activity associated with high arousal items creates a greater temporary inhibition against recall from STM than the lesser neurological activity associated with low arousal items (Walker, & Tarte, 1963). Figure 3 shows the percentage of correct recall obtained on each trial of the STM experiment by each of the control groups. At each trial position the control group which saw only high arousal words had a greater percentage of correct recall than did the control group which saw only low arousal words. It would appear that in this study, action decrement was not functioning in the manner described by Walker and Tarte (1963), because this finding could not

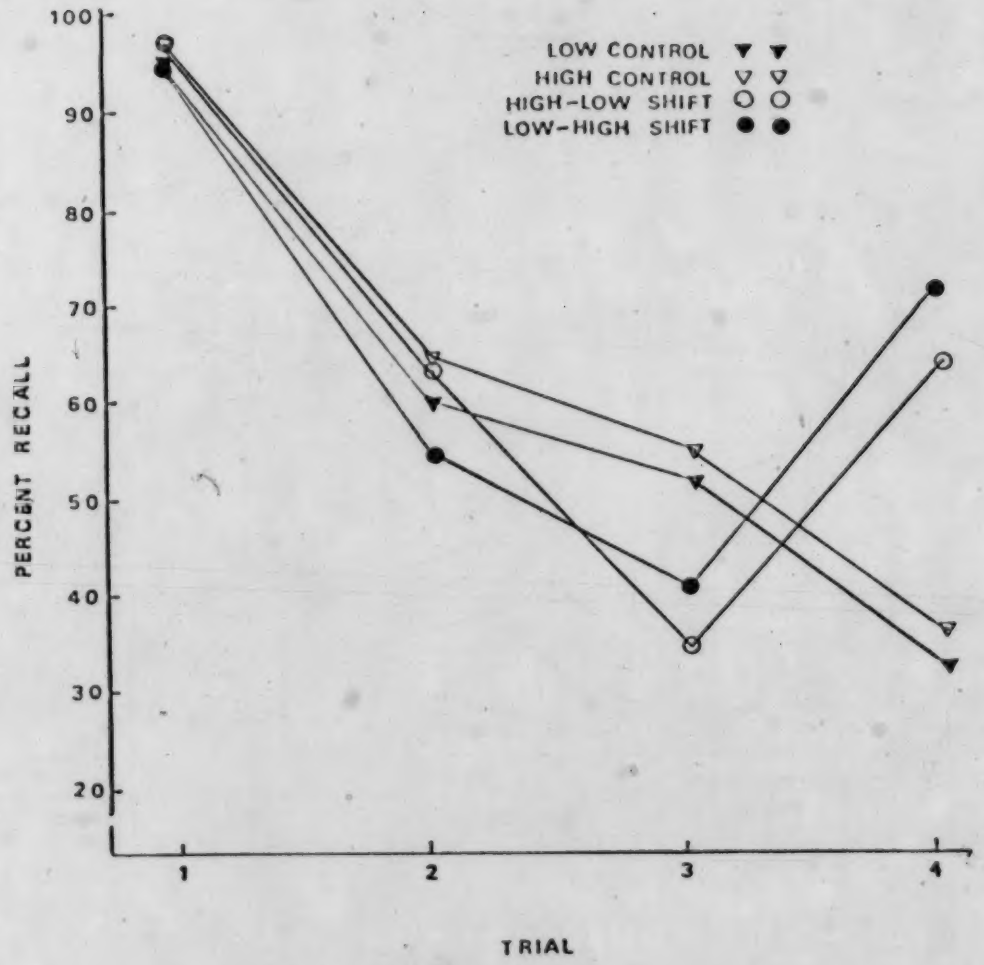


Figure 3 Percent recall from short term memory by the two control groups and the two shift groups

have occurred if greater inhibition of recall for high arousal words than for low arousal words had taken place in STM. The finding is of significance here because it suggests that the PI curve obtained by the high arousal group was not confounded by an action decrement curve. As a result it is not necessary to subject the high arousal control group data to any of the mathmatical manipulations which had been considered in an earlier discussion.

Figure 3 shows the percentage of correct recall obtained on each trial of the STM experiment by each of the experimental groups. It will be recalled that in the case of the high arousal to low arousal shift group, the literature was unclear as to whether any excess nonspecific neural activity which was generated by the three high arousal triads would facilitate, inhibit, or affect the low arousal fourth trial triad. In view of the lack of evidence for the existence of action decrement in the four trial high arousal control group, it would seem unlikely that much nonspecific activity would be generated by only three high arousal trials. This suggestion rests on the undemonstrated assumption that nonspecific neural activity and action decrement function in some type of linear relationship. Because of this uncertainty, three measures were used to determine whether or not nonspecific neural activity had affected the recall of the terminal low arousal triad.

First, a chi-square test of goodness-of-fit indicated that the two experimental group curves did not differ from one another, $\chi^2(4)=2.74$, $.5 < p < .7$. Second, a t test for independent groups with equal ns indicated no significant difference $t(46)=1.31$, $p < .2$, in recall on trial four between the two experimental groups. In other words, the

effect of three high arousal trials on a subsequent low arousal trial did not produce a different recall performance than the effect of three low arousal trials on a subsequent high arousal trial. This result suggests that no action decrement was functioning in the STM situation, however it does not rule out the possibility of some sort of compensating facilitation versus inhibition mechanism operating within the high to low experimental group. Such a complex situation would be unlikely but could conceivably occur as the result of an interaction between the arousal level and the level of PI buildup. To rule out this possibility, the proportion of LTM recall for the low arousal fourth trial of the high to low shift group was compared to the LTM recall of the low arousal control group as a whole. Performance on the shift trial was significantly lower $\chi^2(1)=6.86$, $p<.02$, than performance by the low arousal control group as a whole. If action decrement had been functioning to inhibit the STM recall of the low arousal shift trial, then LTM recall would have been significantly greater for the shift trial than for the low arousal control group as a whole. Although this finding is discussed further in the LTM results section, it is primarily of interest here because it suggests that action decrement was neither transferred to, nor acting upon, the low arousal shift trial.

The foregoing discussion suggests that the STM release from PI data can be presented and discussed in the manner usual to studies of this type and without further reference to any action decrement or non-specific neural activity component.

The Short Term Memory Experiment

Results. Responses were scored as correct when they were given within the recall interval of the trial on which they occurred and without regard to the original order of the words. As is usual in studies of this type, the shift effects appeared to operate in the same manner in both directions. A chi-square test of goodness-of-fit indicated that the two experimental group curves do not differ significantly from one another $\chi^2(4)=2.74$, $.5<p<.7$ Similarly, the two control group curves were found not to differ significantly from one another $\chi^2(4)=3.88$, $.3<p<.5$. Hence, in the manner suggested by Wickens (1970, 1972), both the non-shift groups were combined to form a single control group. Similarly, both the shift groups were combined to form a single experimental group. Figure 4 presents the percentage of correct recall at each trial for these combined experimental and control groups.

As is usually true in a release from PI type of experiment, a progressive decrement in performance occurred over the first three trials for the experimental group, followed by a marked increase in performance on the shift (fourth) trial position. The control group, on the other hand, showed a continuing decrement in performance between the third and the fourth trials.

As was predicted, a $t$ test for independent groups with equal numbers indicated a significant difference, $t(87)=6.62$, $p<.001$, between performance on trial four for both the experimental and the control groups. A $t$ test for dependent groups indicated a significant difference, $t(47)=6.08$, $p<.001$, between performance on trial 3 and on trial 4 for the experimental group. In addition, the two following

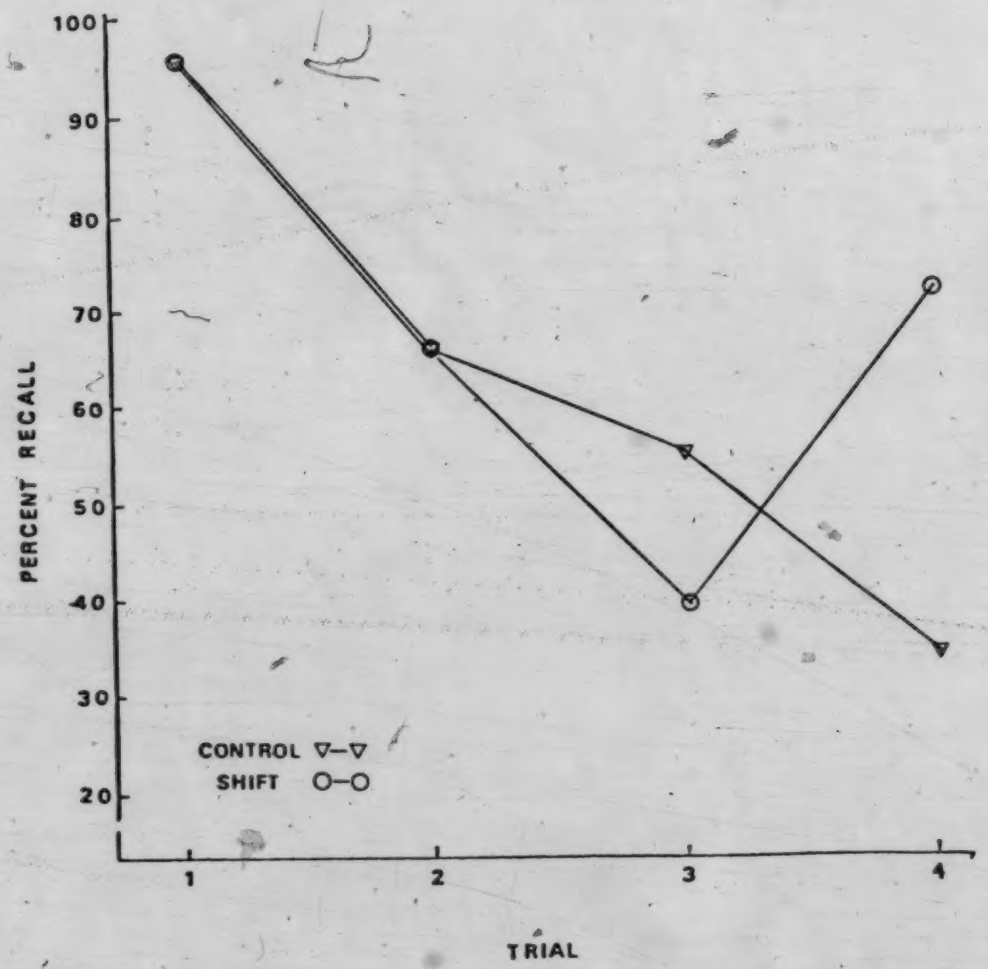


Figure 4 Percent recall from short term memory by the combined control group and shift group

unpredicted significant differences were found. A t test for dependent groups indicated a significant fall, $t(47)=4.29$, $p<.001$ in performance for the control group from trial 3 to trial 4, and a t test for independent groups indicated a significant difference, $t(93)=2.95$, $p<.004$, between performance on trial 3 for the experimental group and for the control group.

These results may also be reported by using the standard Wickens (1970) method of quantifying release from PI. The formula for this method is X/Y x 100 where X is the difference in percent recall between the experimental and the control groups on the shift trial and Y is the difference in percent of recall between the first and the final trials of the control group (see Figure 2). When calculated by this method, the release from PI obtained in this study is 61.0 percent.

Discussion. The decrease in performance which occurred between trials one and four of the control group, and trials one and three of the experimental group is considered to have occurred as a direct consequence of the progressive buildup of PI over sequential trials. This PI interpretation is consistent with the Keppel, and Underwood (1962) analysis of the Peterson and Peterson (1959) experimental results. Both the rapidity and the amount of PI buildup are considered to be a direct consequence of the subjects having reacted to the stimulus materials as specific classes of material. This interpretation is consistent with the Wickens, Born, and Allen (1963) finding that when the same class of material was used for proactive items, marked interference was obtained with as few as three sequential items, but no evidence of PI buildup was found when the sequential test items

were drawn from different classes of materials. With one minor exception, the PI effects found in this study are very similar in nature to those found in other studies (cf. Loess, 1967; Wickens, et al., 1963; Wickens, 1970, 1972). Specifically in this study, the performance decrement attributable to PI buildup over four trials was 62.7 percent of the total initial recall where the percentage of correct recall dropped from 94 percent on trial one to 35 percent on trial four.

The one exception to the standard PI effect, mentioned above, consists of two unexpected, closely related, significant differences which are both associated with PI buildup. The first unexpected difference in recall was found on trial 3 between the experimental and control groups. The second was a significant decrease in recall from trial 3 to trial 4 of the control group. The occurrence of these differences was surprising for a number of reasons. First, the experimental presentation of the stimulus words was identical for both groups up to and including trial three. Second, all the experimental subjects were randomly assigned to experimental positions and the appropriate control subject was always run immediately after each experimental subject, when all the environmental conditions would be most similar. Third, the experimental situation was mechanically standardized. Fourth, the recall on trials 1 and 2 is virtually identical for both groups. Given these circumstances it would not have seemed unreasonable to expect identical recall curves for the two groups up to and including trial 3. Expectations to the contrary, however, differences between the two curves have appeared, not only in this study, but in many similar release from PI studies which have been reported in the literature (cf. McIntyre, Stojak & Mostoway, 1973;

Bird & Goodwin, 1974: Wickens & Engle, 1970; Wickens & Clark, 1968). Most of the writers who have presented similar findings in one or more of their non-shift trials have simply not discussed them. When such findings have been mentioned, they have been attributed either to chance or to some unknown characteristic of the words chosen for the scale (cf. Wickens & Clark, 1968). Indeed, to this writer there does not appear to be any compelling reason to discuss such findings (other than to indicate their existence), because there does not appear to be any existing evidence that the release from PI results are affected in any way.

For example, in the data for this study, if the performance of the control group is adjusted so as to coincide with the performance of the experimental group on trial 3, or vice versa, the final results of the release from PI study are not affected. In view of the above discussion, it would appear that the two unexpected PI buildup differences which have been identified need not be discussed further.

The significant increase in performance which occurred on the fourth trial of the experimental group is considered to represent a reduction of the effect of PI on performance. It will be recalled that a reduction in PI is thought to occur as a result of shifting from one class of material in which PI had accumulated to another class in which PI had not accumulated (cf. Loess, 1967; Wickens & Clark, 1968; Wickens, 1970, 1972). Similarly, the reduction of PI and the consequent increase in performance which were observed in this study are considered to have occurred as a direct consequence of having shifted the presentation of the stimulus material from one category of rated word arousal level to the other. That is, the subjects'

behaviour indicated that the two rated word arousal categories are psychologically separate. PI built up over trials in one category without building up in the other. Hence, when the rated word arousal category was shifted, performance increased because the new category was not so much under the influence of the existing PI.

The finding that two opposing categories within a given dimension serve to trigger release from PI is normally interpreted as meaning that the subjects have encoded the verbal materials by some meaning characteristic which is associated with that dimension (Wickens, 1970, 1972, 1973; Wickens & Clark, 1968; Loess, 1964). In this study two categories of the rated word arousal dimension were shown to trigger release from PI. It is therefore suggested that rated word arousal functions as an encoding dimension in short term memory. Some further consideration is required before this suggestion can be extended beyond this study, however, in that both the general nature of rated word arousal and the specific nature of the words which were used in the study require some further examination.

The rated words: some specific considerations. Osborne and Frankiewicz (1972) in a factor analytic study of high and low arousal words considered the question of whether rated arousal is a distinct attribute of words, or whether it is subsumed by other word attributes such as the Evaluation, Potency, and Activity factors reported by Osgood et al. (1957) and concluded that arousal is partly subsumed by the Activity factor. For their word sample (the 16 words used by Walker and Tarte, 1963) they also found that low arousal words loaded on Evaluation, Arousal-activity, Concreteness-meaningfulness, and Potency and that high arousal words loaded on Evaluation, Activity-

arousal, Concreteness, and Potency. The notion that different levels of word arousal could reside at different locations within Osgood's three-dimensional semantic space suggests the desirability of defining arousal categories used in rated word arousal studies in terms of their differing locations in semantic space, as well as in terms of arousal level.

Subsequent to the completion of the release from PI experiment, the stimulus words from the present study were used as the concepts to be rated in a semantic differential type procedure (cf. Osgood et al., 1957) in an effort to examine the relationship of the arousal categories to Osgood's three main semantic factors. The administration of the semantic differential followed the procedures outlined by Osgood et al. (1957) in terms of scale construction, form of the differential (form II design), and instructions to the subjects. Specifically, three scales selected as good markers from Osgood's thesaurus study were used to measure the presence of each of the factors of Evaluation, Potency, and Activity. Respectively, the scales were: good--bad, reputable--disreputable, clean--dirty, hard--soft, heavy--light, strong--weak, active--passive, fast--slow, emotional--unemotional. In addition, an arousing--nonarousing scale was used to permit comparison with previously determined arousal ratings. One word was presented on each page. Three different scale orderings were used with each word, and in each ordering the polarity of the scales was randomized to minimize response set. Each subject received a 24-page booklet in which the concept ordering was randomized. The subjects were 25 student nurse volunteers from the University of Alberta Hospital.

Table 1 presents the obtained means for, and differences between,

TABLE 1

Means and differences of the Arousal, Evaluation, Activity and Potency components of the two arousal categories

| Component | High Arousal category | Low Arousal category | Difference |
|---|---|---|---|
| Arousal | 6.36 | 4.43 | 1.93 |
| Evaluation | 3.23 | 4.74 | 1.51 |
| Activity | 5.32 | 4.62 | .70 |
| Potency | 5.17 | 4.08 | 1.09 |

the high and low categories for arousal and for each of the semantic components. (For complete ratings see Appendix A) A comparison of the arousal ratings obtained on these same nouns by Osborne (1973) and the present ratings indicated a high inter-group rating reliability, $r$=.96. On this sample of words the high arousal category is negatively evaluated, strongly active and potent. The low arousal category is positively evaluated, active, and neutral with regard to potency. All the differences between the high and low categories were found to be significant: Arousal, $t(23)=8.32$, $p$ .0001; Evaluation, $t(23)=3.11$, .001 $p$ .01; Activity, $t(23)=2.26$, .02 $p$ .05; Potency, $t(23)=2.74$, .01 $p$ .02.

The finding of significant differences between the two arousal categories on the three Osgood dimensions is of central interest to this study in that Wickens and Clark (1968) have obtained significant release from PI on each of these dimensions by shifting between word categories chosen from the ends of each dimension. This suggests a number of possible alternate interpretations which must be considered for the results of this study. First, it could be argued that the release obtained on this study consisted solely of the release from PI obtained along any one of the Osgood dimensions. Second, it could be argued that the obtained release was an instance of multiple semantic encoding in which release from PI occurred along two or perhaps three of the Osgood dimensions and either with or without some arousal component. Third, it could be argued that the obtained release was almost exclusively the result of the difference between the two arousal categories and that the differences along the Osgood dimensions were not significant factors in the release. Fourth, and finally, there is

some evidence to suggest that there is a meaning component to rated word arousal which in itself consists of variance on one or more of the Osgood dimensions. Each of these possible interpretations is considered in turn.

Little or no evidence exists to suggest that the release obtained in the present study was solely the result of PI release along any one of the Osgood dimensions. The question is considered primarily because the specific arguments involved are recurrent in more complex arguments throughout the remainder of this discussion. In the Wickens and Clark (1968) release from PI study of the Osgood dimensions the stimulus words used were chosen on the basis that they fell on either extreme end of one dimension while being relatively neutral on the other two dimensions. The release obtained with these words on each dimension was highly significant (approximately 60%) with the most release being obtained on Activity, less on Evaluation, and least on Potency. In the present study the ranges between the means of the two categories on each of the three Osgood dimensions was far from extreme, with the Evaluation categories separated by approximately 22% of the total dimension range and the Potency categories separated by approximately 16% of the dimension range and the Activity categories separated by approximately 10% of the dimension range. It will be recalled that the release obtained on the present study was also approximately 60%. In order for one to accept the suggestion that the release obtained in the present study was solely the result of PI release along only the Evaluation dimension one would have to be prepared to accept the notion that the use of less than one quarter of the Evaluation dimension produced an encoding effect equal to or greater than the effect

produced by the entire range of the Evaluation dimension. The same is true, of course, of the Activity, and Potency dimensions but with even smaller percentage ranges. Such an explanation is not probable.

It will be recalled from previous discussions that both the rapid PI buildup which occurs during the pre-shift trials and the performance change resulting from the shift are normally regarded as contingent upon homogeneity of the stimulus words with respect to at least some portion of their underlying meaning or of the psychological mechanisms which represent this meaning. In addition, Wickens and Clark (1968) have concluded from their findings that the dimensions of the three Osgood scales are in fact bipolar or, at least, that the two ends of each scale represent clearly different classes of connotative meaning. That is, the meaning associated with each of the Osgood scales is found in two homogeneous populations located at the extremes of each scale. In the present study each of the six Osgood categories are located closer to the center of their respective scales than to either end of the scales, and an inspection of the data (see Appendix A) offers no reason to suspect homogeneity within any of the dimensions. If the Wickens and Clark (1968) interpretations are correct, and there is considerable evidence to suggest that they are (cf. Wickens, 1970, 1972, 1973; Turvey, 1968), it would appear unlikely that any single Osgood dimension could have been responsible for the release obtained on this study. That becomes particularly evident when the bipolar and homogeneity elements, just discussed, are considered simultaneously with the category range element discussed previously.

The second possible interpretation for the results of this study was that the obtained release could represent an instance of multiple

semantic encoding in which release from PI occurred along two or more of the Osgood dimensions. Some theoretical and empirical support exists for this position although it is far from conclusive and often equivocal.

It will be recalled that the release from PI experimental design is predicated upon the assumption that word meaning resides within a collection of encoding dimensions in STM. One implication of this multi-dimensional conceptualization of memory is that most, if not all, words could be considered to have a number of different component values along more than one of these different dimensions. That is, the meaning of a specific given word would be found in the quantitative degree to which it was encoded along a multiplicity of different dimensions. This question of multiple encoding has been extensively considered, and experimental evidence for its occurrence along at least some dimensions has been obtained (cf. Wickens, 1970, 1972, 1973).

In a doctoral dissertation reported by Wickens (1972), Eggemeier (1971) addressed himself specifically to the question of multiple encoding along the two Osgood dimensions of Activity and Evaluation by using a release from PI technique. Wickens (1972) has described the complex methodological approach rather succinctly:

> For the first three trials, the experimenter used words that differed as much as possible, in one direction, from the mean rating score on the Evaluative and the Activity dimensions of the Heise (1965) Semantic Differential norms; for the fourth or shift trial, he used words from the other side of the mean, either for both dimensions (Evaluative and Activity) or for only one of these dimensions. In short there was a double shift for one set of groups and a single shift for the other set. The question asked was whether both dimensions of the semantic differential could be encoded and used by the subject. (p. 204)

Eggemeier found release of approximately 21% for the single shift

groups and of approximately 33% for the double shift groups. Clearly, multiple encoding can occur along at least two of the Osgood dimensions simultaneously. Unfortunately, there does not yet appear to be sufficient evidence to suggest either that multiple encoding works along all dimensions or that it works equally well along those dimensions in which it is known to work.

It should be noted at this point that the demonstration of multiple encoding along two Osgood dimensions is a necessary but not sufficient reason for suggesting that multiple encoding could have occurred in the present study. In the Eggemeier study differences along both of the Osgood scales were demonstrated to have caused marginally significant release from PI independently of one another. In the present study, as previously discussed, it is very unlikely that differences along any one of the Osgood dimensions could have triggered release from PI independently. A sufficient argument would appear to require the demonstration that categories on two dimensions which would not cause a significant release from PI when tested independently could then be combined to trigger a significant amount of release from PI. Some empirical evidence exactly counter to this requirement has been reported.

Wickens (1972) reported an unpublished study by Deese and Wickens which was one of a series of "marked-syntactic" release from PI studies (cf. Wickens, Clark, Hill, & Wittlinger, 1968; Wickens, Shearer, & Timmons, 1972; Shearer & Wickens, 1972) in which syntactic word groupings (verb-adjective, noun-verb, etc.) were used as PI buildup and release categories. With the exception of the Deese and Wickens study, release from PI did not exceed 5% on any of the studies.

(Approximately 20% release is required for significance at $p=.05$.) On the Deese and Wickens study approximately 10% release was obtained. The Deese and Wickens stimulus words were subsequently rated on three semantic differential scales: good--bad, active--passive, and strong--weak. On each scale the unmarked word triads were significantly more positive than were the marked. Wickens (1972) has suggested specifically that these semantic factors were responsible for the amount of release obtained. That is, the presence of significant differences on all three Osgood type semantic scales in this study has been used by Wickens to account for approximately 5% release from PI. This situation, to the extent that it can be generalized to the present study, would seem to indicate at best a minor role for the differences found in the present study between categories of the three Osgood dimensions.

The interpretation that the results of the present study occurred as a result of multiple semantic encoding in which release from PI occurred along two or more of the Osgood dimensions would appear to be somewhat tenuous at this point.

The third interpretation, that the release obtained in the present study was almost exclusively the result of the differences between the two arousal categories and that the differences between the categories of the Osgood dimensions were not significant factors is supported by much of the evidence previously discussed. To this point arousal is left as the only original independent variable to be considered. In the present study two approaches are used in the consideration of arousal. The first consists essentially of the discussion which composes Chapter I. In brief, Osborne & Frankiewicz (1972) have

Wickens (1973) has reported the results of a series of four release from PI studies conducted by Wickens and Lindberg in an effort to determine the encoding properties of the four dimensions in semantic space which Bentler and LaVoie (1973) have suggested should be added to the original Osgood three. Of the four dimensions, which Bentler and LaVoie termed Density (gang--few), Organization (structured--scrambled), Reality (authentic--fake), and Familiar (routine--novel), only the dimensions of Density and Reality produced significant amounts of release. Subsequently, the words from these two new dimensions were rated by subjects on the three Osgood dimensions and significant differences were found to exist between the two bipolar categories of each Bentler and La Voie dimension for each of the three Osgood dimensions. This finding suggested to Wickens, among other things, the question of the encoding power of moderate values of one or two dimensions in the release from PI paradigm. To this writer the results, along with others to be discussed, suggested the possibility of the subsumption of subordinate classes of meaning attributes within a hierarchy of classes of meaning. This notion is discussed first generally, then in terms of arousal, and finally in terms of the specific results obtained on the present study.

In the previously discussed Deese and Wickens (1972) "marked-syntactic" release from PI study the shift categories differed significantly along each Osgood dimension, but release from PI did not occur. In the Wickens and Lindberg (1972) release from PI study of the Bentler and La Voie (1972) dimensions the shift categories differed significantly along each

Osgood dimension yet significant release from PI was obtained along the dimensions under test. In the present study the shift categories differed significantly along each Osgood dimension and yet release was obtained on the arousal dimension. In both the latter studies the stimulus word categories appear to have been processed as independent homogeneous groups. The question which must be asked is whether the categories were recognized as being homogeneous and independent in spite of, or because of, their Osgood semantic meaning variances.

The Eggemeier (1971) study demonstrated that variances on two meaning dimensions when combined served to enhance the encoding effect. This, when considered with the findings reported in the previous paragraph suggests that specific categories, particularly categories associated with some meaning dimension, may be recognized as homogeneous and independent (i.e., encoded) because of, rather than in spite of, variances on other semantic dimensions. In each study of this type mentioned so far the other semantic dimensions have been the three Osgood dimensions. The suggestion that some encoding dimension may exist, at least in part, as some specific pattern or combination of variance along the Osgood dimensions has already been identified as speculative. However, because the suggestion, as it concerns arousal, arose directly from the findings of this study and because it is likely to be a fruitful area for further research further discussion will show exactly where such a suggestion, should it be subsequently confirmed, would fit in the mosaic of modern arousal theory.

Berlyne (1967) has suggested that if arousal functions as a drive component it may do so, among other ways, by triggering a specific class of learned or innate behaviour so that class specific results

would follow a specific arousal determinant. This writer has been unable to locate any statement of a specifically defined mechanism which could explain the functioning of part of a generalized drive component as an appropriate stimulus to elicit a learned response. Some meaning component to arousal would appear to be required for the existence of such a mechanism and that meaning could be supplied by variance along the Osgood dimensions which may serve as subordinate encoding components during the experience and encoding of arousal. This would be the mechanism by which people obtain specific cognitive awareness of drive states. Such a position would be a specific instance of the McNulty and Noseworthy (1966) suggestion that individuals may channel their arousal through specific modalities in such a way that physiological indices may not validly monitor a subject's level of arousal.

The Long Term Memory Results

The long term memory component of this study was specifically intended to serve as an instrument with which to identify and monitor possible action decrement processes which could have confounded the results of the STM experiment. The decision to use a LTM component was based on the suggestion that the successive introduction of high arousal stimuli into an experimental situation would create both an increasing total amount of intense consolidating activity and an increasing amount of non-specific neural activity. If the concept of action decrement was valid and if the stimuli were sufficiently arousing, the result of such a situation would be both a progressive decrement in word recall as the STM experiment proceeded and a progressive increment in LTM word recall over successive trial positions.

Figure 5 presents the percentage of correct recall from LTM at each trial position for the high arousal control group and for the high to low arousal shift group. A $t$ test for dependent groups indicated a significant increase in recall, $t$ (21) = 2.56, $p < .02$ between trials 1 and 4 of the high arousal control group. The decrease in recall between trials 1 and 3 of the high to low arousal shift group was not significant, $t$ (22) = .972, $p > .3$

The finding of a progressive increase in LTM recall over trials by the high arousal control group suggests that action decrement was functioning during the presentation and learning of the stimulus words. It will be recalled, from a previous discussion, that action decrement was shown not to have affected the STM results. Initially these two findings appear to be incompatible with each other from within the framework of action decrement theory, in that a decrease in immediate STM recall is the necessarily required evidence of ongoing intense consolidation activity which, in turn, is responsible for increased LTM recall. Although these findings appear to be incompatible within the framework of action decrement theory, they can not be considered as detrimental to the theory until a number of other factors have been considered.

If action decrement due to the high arousal stimulus words was responsible for the progressive increase in recall of the high arousal control group over trials, it would seem reasonable to expect a corresponding increase in recall over the first three high arousal trials of the high to low arousal shift group. As reported above, a non-significant decrease in recall was found. In addition (as discussed in the Secondary Hypotheses section) it would have seemed reasonable to

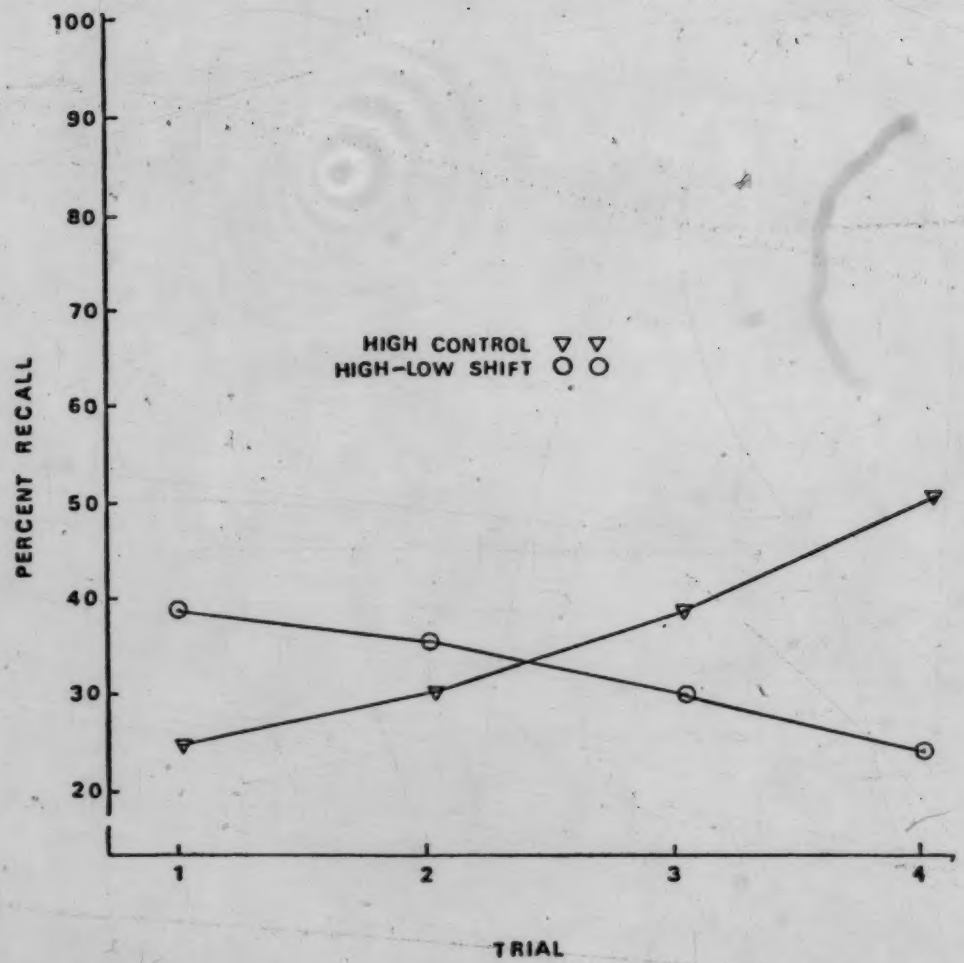


Figure 5 Percent recall from long term memory of the high arousal control group and the high to low arousal shift group

expect any non-specific neural activity associated with the first three high arousal trials to enhance the LTM recall of the subsequent low arousal trial. A test of proportions for independent groups indicated that recall on the shift trial was significantly lower, $\chi^2(1) = 6.86$, $p < .03$, than recall by the low arousal control group as a whole. These two findings indicate that any action decrement which may have been functioning in the case of the high arousal control group, if any, was not functioning to an appreciable extent within the high to low shift group.

Both the high to low arousal shift group LTM findings and the STM results suggest that action decrement was not functioning during the STM experiment. This is not very surprising when it is recalled that a considerable effort was made to eliminate or reduce the presence of non-specific neural activity by selecting non-extreme high arousal words. The progressive increment in LTM recall by the high arousal control group remains to be explained, however, and this may be done from within the action decrement theoretical framework.

Inspection of the overall LTM results (Figure 6) suggested a general increase in recall over trials for both the control and the experimental groups. Although this increase was not significant either for the control group, $t\ (45) = 1.39$; $p > .1$, or for the experimental group, $t\ (47) = 1.26$; $p > .2$, it suggested the possibility that some task independent determinant of arousal could have been functioning to produce arousal in the STM experiment.

There is some evidence to suggest that test and performance anxiety could have provided a task independent source of arousal. After each STM experiment was concluded, the subject was asked two

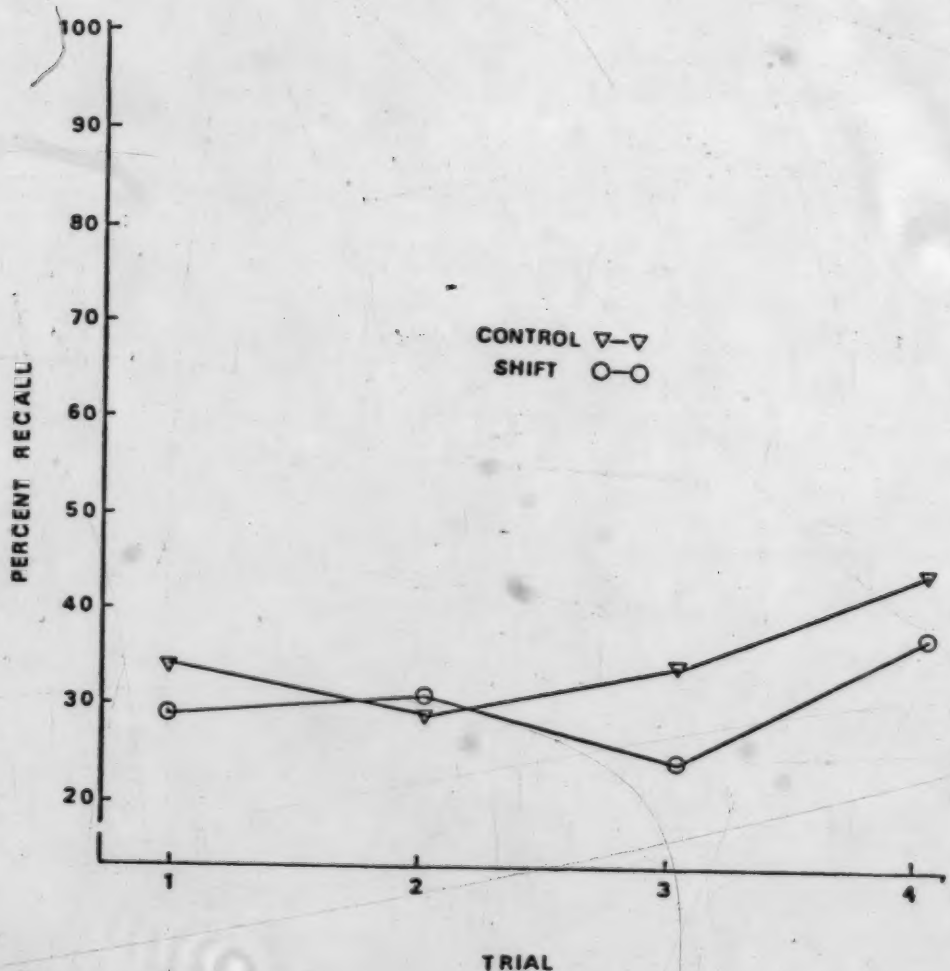


Figure 6 Percent recall from long term memory of the combined control and shift groups

specific questions relating to anxiety as part of a brief discussion which was intended to obtain general feedback about the experiment. First, each subject was asked to rate, on a scale of 1 to 10, how anxious he normally felt during a university mid-term or final exam. On this scale 1 was the most relaxed he had ever been and 10 was the most anxious. Second, he was asked to rate, on the same scale, how anxious he had been during the STM experiment. The mean of this subjective anxiety rating over all experimental groups was slightly less for the university exams than for the STM experiment. That is, most subjects found the STM experiment to be more anxiety producing than mid-term and final exams. These results tend to corroborate the experimenter's observation that the behaviour of most subjects appeared to be more anxious at the conclusion of the experiment than at the beginning.

From within the theoretical framework of action decrement the progressive increase in recall for the high arousal control group between trials 1 and 4 could be regarded as the result of task independent test anxiety generated by the subjects awareness of his progressively worsening performance and bolstered by the arousal associated with highly arousing words. From this view the performance of the high to low arousal shift group would be explained by suggesting that much less non-specific neural activity was in evidence because the release from PI allowed a much better performance which in turn caused less frustration and less anxiety. In addition the final low arousal trial did not add task specific arousal to the situation. This interpretation suggests that the data from this study may be consistent with action decrement theory even though action decrement did not have

a significant effect on all of the results.

It should be noted that the LTM results may alternately be interpreted without the consideration of action decrement theory. For example, the progressive increase in recall for the high arousal control group between trials 1 and 4 could be regarded either as a recency effect or as the result of retroactive interference (RI) where the learning of each successive trial would have interfered with the recall of previously learned trials. The decrease in recall by the high to low arousal shift group could be regarded as the result of incomplete temporal release from PI. The recall from LTM by the combined control groups, as shown by Figure 6, is a slightly U shaped curve over trials and would appear to indicate a minimal effect of primacy, as well as a considerable recency effect. This study does not provide sufficient evidence to determine whether the LTM results are best explained only by the effect of minimal action decrement, by serial position effect, by incomplete temporal release from PI, or by some combination of all of these possibilities. It will be recalled that the partial and equivocal evidence of action decrement which has been observed in LTM has allowed the STM results to be interpreted in a straightforward manner and exactly as intended. This was the primary purpose of the LTM experimental component, and to this end it appears to have been successful. From the beginning further interpretation of the LTM data was not intended unless unequivocal results were obtained. Further interpretation is not attempted because the data appear to be the result of some unknown combination of effects.

Summary

The primary purpose of this study was to investigate rated word

arousal as an encoding dimension in short term memory by using a release from proactive interference paradigm. Because arousal theory suggested the possibility that action decrement could confound the results obtained by using the release from PI technique, the experimental design was modified by eliminating extremely arousing words so as to minimize or eliminate the effect of action decrement. The long term memory component was introduced to monitor the effectiveness of the modification in the experimental design and to provide data which could be used to unconfound the STM results if the modification was found to be ineffective. An analysis of the STM results indicated that they had not been affected by action decrement, and an analysis of the LTM results indicated the possible presence of only a minimal amount of action decrement, if any. The results of this study indicate that rated word arousal, as an operationally derived variable, functions as an encoding attribute in STM.

It is probably appropriate, in closing, to explicitly state that in this study rated word arousal has been treated as an operationally defined intervening variable. The purpose of this study was not to explore rated word arousal as a hypothetical construct, although that would no doubt make an interesting study in its own right.

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| High Arousal Triads | Frequency | Imagery | Arousal | | Evaluation | Activity | Potency |
|---|---|---|---|---|---|---|---|
| | | | one | two | | | |
| avalanche | 4 | 6.27 | 5.54 | 6.80 | 2.55 | 6.12 | 6.07 |
| morgue | 2 | 6.63 | 4.78 | 6.24 | 3.89 | 4.25 | 4.71 |
| ghost | 2 | 5.37 | 5.00 | 6.32 | 3.56 | 4.87 | 3.59 |
| skull | 13 | 6.47 | 4.46 | 5.56 | 4.61 | 4.32 | 4.96 |
| brute | 14 | 5.17 | 4.60 | 6.24 | 2.13 | 5.28 | 6.25 |
| alcohol | 15 | 6.47 | 4.97 | 6.36 | 3.79 | 5.53 | 4.65 |
| policeman | 22 | 6.70 | 4.55 | 5.84 | 5.76 | 5.40 | 5.28 |
| volcano | 14 | 6.63 | 5.31 | 6.68 | 2.40 | 6.28 | 5.56 |
| agony | 24 | 5.43 | 5.24 | 6.88 | 3.03 | 5.44 | 5.33 |
| jail | 22 | 6.43 | 4.58 | 6.12 | 2.36 | 4.59 | 5.19 |
| snake | 28 | 6.90 | 4.94 | 6.52 | 2.56 | 5.36 | 4.51 |
| disaster | 23 | 5.10 | 5.43 | 6.84 | 2.13 | 6.48 | 6.00 |
| **Low Arousal Triads** | | | | | | | |
| ankle | 21 | 6.77 | 3.54 | 3.96 | 4.63 | 4.69 | 4.83 |
| harp | 20 | 6.60 | 4.04 | 5.68 | 5.65 | 5.01 | 2.92 |
| cigar | 16 | 6.80 | 3.41 | 4.04 | 2.55 | 3.95 | 4.75 |
| toast | 20 | 6.57 | 3.53 | 4.24 | 5.55 | 4.08 | 3.44 |
| hamlet | 15 | 5.87 | 3.64 | 4.32 | 4.83 | 4.19 | 4.27 |
| juggler | 1 | 6.10 | 3.64 | 4.56 | 5.03 | 5.69 | 4.04 |
| appliance | 7 | 5.73 | 2.83 | 4.40 | 4.65 | 4.56 | 4.47 |
| caravan | 7 | 5.83 | 3.64 | 3.64 | 5.36 | 4.39 | 4.87 |
| leaflet | 7 | 5.47 | 2.50 | 3.56 | 4.29 | 3.44 | 3.41 |
| fiord | 2 | 5.70 | 3.62 | 4.56 | 4.76 | 4.53 | 4.45 |
| hurdle | 2 | 6.33 | 3.86 | 5.16 | 4.69 | 5.84 | 5.04 |
| banner | 23 | 5.93 | 3.34 | 5.08 | 4.91 | 5.11 | 3.53 |

Appendix B

Low to High Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 13 | harp<br>cigar<br>ankle | hurdle<br>fiord<br>banner | caravan<br>appliance<br>leaflet | brute<br>skull<br>alcohol |
| 14 | hamlet<br>juggler<br>toast | harp<br>cigar<br>ankle | hurdle<br>fiord<br>banner | volcano<br>policeman<br>agony |
| 15 | caravan<br>leaflet<br>appliance | hamlet<br>juggler<br>toast | harp<br>cigar<br>ankle | snake<br>jail<br>disaster |
| 16 | hurdle<br>banner<br>fiord | caravan<br>leaflet<br>appliance | hamlet<br>juggler<br>toast | morgue<br>avalanche<br>ghost |
| 17 | cigar<br>ankle<br>harp | hurdle<br>banner<br>fiord | caravan<br>leaflet<br>appliance | brute<br>alcohol<br>skull |
| 18 | juggler<br>toast<br>hamlet | cigar<br>ankle<br>harp | hurdle<br>banner<br>fiord | volcano<br>agony<br>policeman |
| 19 | leaflet<br>appliance<br>caravan | juggler<br>toast<br>hamlet | cigar<br>ankle<br>harp | snake<br>disaster<br>jail |
| 20 | banner<br>fiord<br>hurdle | leaflet<br>appliance<br>caravan | juggler<br>toast<br>hamlet | avalanche<br>ghost<br>morgue |
| 21 | cigar<br>harp<br>ankle | banner<br>fiord<br>hurdle | leaflet<br>appliance<br>caravan | alcohol<br>skull<br>brute |
| 22 | juggler<br>hamlet<br>toast | cigar<br>harp<br>ankle | banner<br>fiord<br>hurdle | agony<br>policeman<br>volcano |
| 23 | leaflet<br>caravan<br>appliance | juggler<br>hamlet<br>toast | cigar<br>harp<br>ankle | disaster<br>jail<br>snake |
| 24 | banner<br>hurdle<br>fiord | leaflet<br>caravan<br>appliance | juggler<br>hamlet<br>toast | ghost<br>morgue<br>avalanche |

Appendix B

Low to High Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 1 | ankle<br>harp<br>cigar | banner<br>hurdle<br>fiord | leaflet<br>caravan<br>appliance | alcohol<br>brute<br>skull |
| 2 | toast<br>hamlet<br>juggler | ankle<br>harp<br>cigar | banner<br>hurdle<br>fiord | agony<br>volcano<br>policeman |
| 3 | appliance<br>caravan<br>leaflet | toast<br>hamlet<br>juggler | ankle<br>harp<br>cigar | disaster<br>snake<br>jail |
| 4 | fiord<br>hurdle<br>banner | appliance<br>caravan<br>leaflet | toast<br>hamlet<br>juggler | avalanche<br>morgue<br>ghost |
| 5 | ankle<br>cigar<br>harp | fiord<br>hurdle<br>banner | appliance<br>caravan<br>leaflet | skull<br>brute<br>alcohol |
| 6 | toast<br>juggler<br>hamlet | ankle<br>cigar<br>harp | fiord<br>hurdle<br>banner | policeman<br>volcano<br>agony |
| 7 | appliance<br>leaflet<br>caravan | toast<br>juggler<br>hamlet | ankle<br>cigar<br>harp | jail<br>snake<br>disaster |
| 8 | fiord<br>banner<br>hurdle | appliance<br>leaflet<br>caravan | toast<br>juggler<br>hamlet | ghost<br>avalanche<br>morgue |
| 9 | harp<br>ankle<br>cigar | fiord<br>banner<br>hurdle | appliance<br>leaflet<br>caravan | skull<br>alcohol<br>brute |
| 10 | hamlet<br>toast<br>juggler | harp<br>ankle<br>cigar | fiord<br>banner<br>hurdle | policeman<br>agony<br>volcano |
| 11 | caravan<br>appliance<br>leaflet | hamlet<br>toast<br>juggler | harp<br>ankle<br>cigar | jail<br>disaster<br>snake |
| 12 | hurdle<br>fiord<br>banner | caravan<br>appliance<br>leaflet | hamlet<br>toast<br>juggler | morgue<br>ghost<br>avalanche |

Appendix C

High to Low Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 37 | morgue<br>avalanche<br>ghost | snake<br>jail<br>disaster | volcano<br>policeman<br>agony | hamlet<br>toast<br>juggler |
| 38 | brute<br>alcohol<br>skull | morgue<br>avalanche<br>ghost | snake<br>jail<br>disaster | caravan<br>appliance<br>leaflet |
| 39 | volcano<br>agony<br>policeman | brute<br>alcohol<br>skull | morgue<br>avalanche<br>ghost | hurdle<br>fiord<br>banner |
| 40 | snake<br>disaster<br>jail | volcano<br>agony<br>policeman | brute<br>alcohol<br>skull | harp<br>cigar<br>ankle |
| 41 | avalanche<br>ghost<br>morgue | snake<br>disaster<br>jail | volcano<br>agony<br>policeman | hamlet<br>juggler<br>toast |
| 42 | alcohol<br>skull<br>brute | avalanche<br>ghost<br>morgue | snake<br>disaster<br>jail | caravan<br>leaflet<br>appliance |
| 43 | agony<br>policeman<br>volcano | alcohol<br>skull<br>brute | avalanche<br>ghost<br>morgue | hurdle<br>banner<br>fiord |
| 44 | disaster<br>jail<br>snake | agony<br>policeman<br>volcano | alcohol<br>skull<br>brute | cigar<br>ankle<br>harp |
| 45 | ghost<br>morgue<br>avalanche | disaster<br>jail<br>snake | agony<br>policeman<br>volcano | juggler<br>toast<br>hamlet |
| 46 | alcohol<br>brute<br>skull | ghost<br>morgue<br>avalanche | disaster<br>jail<br>snake | leaflet<br>appliance<br>caravan |
| 47 | agony<br>volcano<br>policeman | alcohol<br>brute<br>skull | ghost<br>morgue<br>avalanche | banner<br>fiord<br>hurdle |
| 48 | disaster<br>snake<br>jail | agony<br>volcano<br>policeman | alcohol<br>brute<br>skull | cigar<br>harp<br>ankle |

Appendix C

High to Low Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 25 | avalanche<br>morgue<br>ghost | disaster<br>snake<br>jail | agony<br>volcano<br>policeman | juggler<br>hamlet<br>toast |
| 26 | skull<br>brute<br>alcohol | avalance<br>morgue<br>ghost | disaster<br>snake<br>jail | leaflet<br>caravan<br>appliance |
| 27 | policeman<br>volcano<br>agony | skull<br>brute<br>alcohol | avalanche<br>morgue<br>ghost | banner<br>hurdle<br>fiord |
| 28 | jail<br>snake<br>disaster | policeman<br>volcano<br>agony | skull<br>brute<br>alcohol | ankle<br>harp<br>cigar |
| 29 | ghost<br>avalanche<br>morgue | jail<br>snake<br>disaster | policeman<br>volcano<br>agony | toast<br>hamlet<br>juggler |
| 30 | skull<br>alcohol<br>brute | ghost<br>avalanche<br>morgue | jail<br>snake<br>disaster | appliance<br>caravan<br>leaflet |
| 31 | policeman<br>agony<br>vlocano | skull<br>alcohol<br>brute | ghost<br>avalanche<br>morgue | fiord<br>hurdle<br>banner |
| 32 | jail<br>disaster<br>snake | policeman<br>agony<br>volcano | skull<br>alcohol<br>brute | ankle<br>cigar<br>harp |
| 33 | morgue<br>ghost<br>avalanche | jail<br>disaster<br>snake | policeman<br>agony<br>volcano | toast<br>juggler<br>hamlet |
| 34 | brute<br>skull<br>alcohol | morgue<br>ghost<br>avalanche | jail<br>disaster<br>snake | appliance<br>leaflet<br>caravan |
| 35 | volcano<br>policeman<br>agony | brute<br>skull<br>alcohol | morgue<br>ghost<br>avalanche | fiord<br>banner<br>hurdle |
| 36 | snake<br>jail<br>disaster | volcano<br>policeman<br>agony | brute<br>skull<br>alcohol | harp<br>ankle<br>cigar |

Appendix D

High Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 61 | morgue<br>avalanche<br>ghost | snake<br>jail<br>disaster | volcano<br>policeman<br>agony | brute<br>skull<br>alcohol |
| 62 | brute<br>alcohol<br>skull | morgue<br>avalanche<br>ghost | snake<br>jail<br>disaster | volcano<br>policeman<br>agony |
| 63 | volcano<br>agony<br>policeman | brute<br>alcohol<br>skull | morgue<br>avalanche<br>ghost | snake<br>jail<br>disaster |
| 64 | snake<br>disaster<br>jail | volcano<br>agony<br>policeman | brute<br>alcohol<br>skull | morgue<br>avalanche<br>ghost |
| 65 | avalanche<br>ghost<br>morgue | snake<br>disaster<br>jail | volcano<br>agony<br>policeman | brute<br>alcohol<br>skull |
| 66 | alcohol<br>skull<br>brute | avalanche<br>ghost<br>morgue | snake<br>disaster<br>jail | volcano<br>agony<br>policeman |
| 67 | agony<br>policeman<br>volcano | alcohol<br>skull<br>brute | avalanche<br>ghost<br>morgue | snake<br>disaster<br>jail |
| 68 | disaster<br>jail<br>snake | agony<br>policeman<br>volcano | alcohol<br>skull<br>brute | avalanche<br>ghost<br>morgue |
| 69 | ghost<br>morgue<br>avalanche | disaster<br>jail<br>snake | agony<br>policeman<br>volcano | alcohol<br>skull<br>brute |
| 70 | alcohol<br>brute<br>skull | ghost<br>morgue<br>avalanche | disaster<br>jail<br>snake | agony<br>policeman<br>volcano |
| 71 | agony<br>volcano<br>policeman | alcohol<br>brute<br>skull | ghost<br>morgue<br>avalanche | disaster<br>jail<br>snake |
| 72 | disaster<br>snake<br>jail | agony<br>volcano<br>policeman | alcohol<br>brute<br>skull | ghost<br>morgue<br>avalanche |

## Appendix D

### High Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 49 | avalanche<br>morgue<br>ghost | disaster<br>snake<br>jail | agony<br>volcano<br>policeman | alcohol<br>brute<br>skull |
| 50 | skull<br>brute<br>alcohol | avalance<br>morgue<br>ghost | disaster<br>snake<br>jail | agony<br>volcano<br>policeman |
| 51 | policeman<br>volcano<br>agony | skull<br>brute<br>alcohol | avalanche<br>morgue<br>ghost | disaster<br>snake<br>jail |
| 52 | jail<br>snake<br>disaster | policeman<br>volcano<br>agony | skull<br>brute<br>alcohol | avalanche<br>morgue<br>ghost |
| 53 | ghost<br>avalanche<br>morgue | jail<br>snake<br>disaster | policeman<br>volcano<br>agony | skull<br>brute<br>alcohol |
| 54 | skull<br>alcohol<br>brute | ghost<br>avalanche<br>morgue | jail<br>snake<br>disaster | policeman<br>volcano<br>agony |
| 55 | policeman<br>agony<br>vlocano | skull<br>alcohol<br>brute | ghost<br>avalanche<br>morgue | jail<br>snake<br>disaster |
| 56 | jail<br>disaster<br>snake | policeman<br>agony<br>volcano | skull<br>alcohol<br>brute | ghost<br>avalanche<br>morgue |
| 57 | morgue<br>ghost<br>avalanche | jail<br>disaster<br>snake | policeman<br>agony<br>volcano | skull<br>alcohol<br>brute |
| 58 | brute<br>skull<br>alcohol | morgue<br>ghost<br>avalanche | jail<br>disaster<br>snake | policeman<br>agony<br>volcano |
| 59 | volcano<br>policeman<br>agony | brute<br>skull<br>alcohol | morgue<br>ghost<br>avalanche | jail<br>disaster<br>snake |
| 60 | snake<br>jail<br>disaster | volcano<br>policeman<br>agony | brute<br>skull<br>alcohol | morgue<br>ghost<br>avalanche |

## Appendix E

### Low Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 85 | harp<br>cigar<br>ankle | hurdle<br>fiord<br>banner | caravan<br>appliance<br>leaflet | hamlet<br>toast<br>juggler |
| 86 | hamlet<br>juggler<br>toast | harp<br>cigar<br>ankle | hurdle<br>fiord<br>banner | caravan<br>appliance<br>leaflet |
| 87 | caravan<br>leaflet<br>appliance | hamlet<br>juggler<br>toast | harp<br>cigar<br>ankle | hurdle<br>fiord<br>banner |
| 88 | hurdle<br>banner<br>fiord | caravan<br>leaflet<br>appliance | hamlet<br>juggler<br>toast | harp<br>cigar<br>ankle |
| 89 | cigar<br>ankle<br>harp | hurdle<br>banner<br>fiord | caravan<br>leaflet<br>appliance | hamlet<br>juggler<br>toast |
| 90 | juggler<br>toast<br>hamlet | cigar<br>ankle<br>harp | hurdle<br>banner<br>fiord | caravan<br>leaflet<br>appliance |
| 91 | leaflet<br>appliance<br>caravan | juggler<br>toast<br>hamlet | cigar<br>ankle<br>harp | hurdle<br>banner<br>fiord |
| 92 | banner<br>fiord<br>hurdle | leaflet<br>appliance<br>caravan | juggler<br>toast<br>hamlet | cigar<br>ankle<br>harp |
| 93 | cigar<br>harp<br>ankle | banner<br>fiord<br>hurdle | leaflet<br>appliance<br>caravan | juggler<br>toast<br>hamlet |
| 94 | juggler<br>hamlet<br>toast | cigar<br>harp<br>ankle | banner<br>fiord<br>hurdle | leaflet<br>appliance<br>caravan |
| 95 | leaflet<br>caravan<br>appliance | juggler<br>hamlet<br>toast | cigar<br>harp<br>ankle | banner<br>fiord<br>hurdle |
| 96 | banner<br>hurdle<br>fiord | leaflet<br>caravan<br>appliance | juggler<br>hamlet<br>toast | cigar<br>harp<br>ankle |

# Appendix E

## Low Arousal

| No. | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|---|---|---|---|---|
| 73 | ankle<br>harp<br>cigar | banner<br>hurdle<br>fiord | leaflet<br>caravan<br>appliance | juggler<br>hamlet<br>toast |
| 74 | toast<br>hamlet<br>juggler | ankle<br>harp<br>cigar | banner<br>hurdle<br>fiord | leaflet<br>caravan<br>appliance |
| 75 | appliance<br>caravan<br>leaflet | toast<br>hamlet<br>juggler | ankle<br>harp<br>cigar | banner<br>hurdle<br>fiord |
| 76 | fiord<br>hurdle<br>banner | appliance<br>caravan<br>leaflet | toast<br>hamlet<br>juggler | ankle<br>harp<br>cigar |
| 77 | ankle<br>cigar<br>harp | fiord<br>hurdle<br>banner | appliance<br>caravan<br>leaflet | toast<br>hamlet<br>juggler |
| 78 | toast<br>juggler<br>hamlet | ankle<br>cigar<br>harp | fiord<br>hurdle<br>banner | appliance<br>caravan<br>leaflet |
| 79 | appliance<br>leaflet<br>caravan | toast<br>juggler<br>hamlet | ankle<br>cigar<br>harp | fiord<br>hurdle<br>banner |
| 80 | fiord<br>banner<br>hurdle | appliance<br>leaflet<br>caravan | toast<br>juggler<br>hamlet | ankle<br>cigar<br>harp |
| 81 | harp<br>ankle<br>cigar | fiord<br>banner<br>hurdle | appliance<br>leaflet<br>caravan | toast<br>juggler<br>hamlet |
| 82 | hamlet<br>toast<br>juggler | harp<br>ankle<br>cigar | fiord<br>banner<br>hurdle | appliance<br>leaflet<br>caravan |
| 83 | caravan<br>appliance<br>leaflet | hamlet<br>toast<br>juggler | harp<br>ankle<br>cigar | fiord<br>banner<br>hurdle |
| 84 | hurdle<br>fiord<br>banner | caravan<br>appliance<br>leaflet | hamlet<br>toast<br>juggler | harp<br>ankle<br>cigar |

## Appendix F

### The Random Assignment of Subjects

| Arrival Order | Shift Group | Control Group | Arrival Order | Shift Group | Control Group |
|---|---|---|---|---|---|
| 1 | 45 | | 49 | 40 | |
| 2 | | 93 | 50 | | 88 |
| 3 | 35 | | 51 | 33 | |
| 4 | | 83 | 52 | | 81 |
| 5 | 18 | | 53 | 44 | |
| 6 | | 66 | 54 | | 92 |
| 7 | 37 | | 55 | 6 | |
| 8 | | 85 | 56 | | 54 |
| 9 | 15 | | 57 | 29 | |
| 10 | | 63 | 58 | | 77 |
| 11 | 8 | | 59 | 5 | |
| 12 | | 56 | 60 | | 53 |
| 13 | 17 | | 61 | 1 | |
| 14 | | 65 | 62 | | 49 |
| 15 | 46 | | 63 | 36 | |
| 16 | | 94 | 64 | | 84 |
| 17 | 38 | | 65 | 21 | |
| 18 | | 86 | 66 | | 69 |
| 19 | 7 | | 67 | 26 | |
| 20 | | 55 | 68 | | 74 |
| 21 | 48 | | 69 | 42 | |
| 22 | | 96 | 70 | | 90 |
| 23 | 22 | | 71 | 11 | |
| 24 | | 70 | 72 | | 59 |
| 25 | 41 | | 73 | 32 | |
| 26 | | 89 | 74 | | 80 |
| 27 | 2 | | 75 | 10 | |
| 28 | | 50 | 76 | | 58 |
| 29 | 30 | | 77 | 9 | |
| 30 | | 78 | 78 | | 57 |
| 31 | 19 | | 79 | 39 | |
| 32 | | 67 | 80 | | 87 |
| 33 | 31 | | 81 | 27 | |
| 34 | | 79 | 82 | | 75 |
| 35 | 34 | | 83 | 12 | |
| 36 | | 82 | 84 | | 60 |
| 37 | 3 | | 85 | 43 | |
| 38 | | 51 | 86 | | 91 |
| 39 | 20 | | 87 | 4 | |
| 40 | | 68 | 88 | | 52 |
| 41 | 28 | | 89 | 14 | |
| 42 | | 76 | 90 | | 62 |
| 43 | 16 | | 91 | 47 | |
| 44 | | 64 | 92 | | 95 |
| 45 | 25 | | 93 | 23 | |
| 46 | | 73 | 94 | | 71 |
| 47 | 13 | | 95 | 24 | |
| 48 | | 61 | 96 | | 72 |

Appendix G

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DEPARTMENT OF EDUCATIONAL PSYCHOLOGY
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THE UNIVERSITY OF ALBERTA
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T6G 2G5

SN_____

Hello again,

A central purpose of the study you took part in yesterday was to discover what types of words, if any, are remembered for long periods of time after they have been learned in the particular type of situation you experienced. Of course, I couldn't tell you that yesterday, or you might have made a special effort to remember, and that would have damaged the results. If you can recall any of the words used in the experiment yesterday, please write them down at the bottom of the page. If you can't recall any, please write "none".

Please don't discuss the contents of this letter with anyone. If you opened this letter more than one hour before, or one hour after the time on the envelope, please note the exact time so that a correction can be made. This is vital to the research. I'll send out your $1.00 just as soon as I receive your reply. Once again, thank you for taking the time to participate. Your co-operation is very much appreciated.

Sincerely yours,

Allan Hayduk

Words recalled (if any)

Date and time opened_____

Other comments (if any)

Appendix H

STM Experiment Instructions

Hello. Thank you for coming in to take part in our experiment today. Actually, we have two little experiments. The first one is a short but rather demanding one. I'd like to go through, in detail, what is expected of you on the first experiment. It consists of a series of slides from which you will be required to memorize certain types of information. I will show you the slides one at a time to explain to you exactly what each one will mean to you. The first slide, which you see here is an asterisk slide. It means please pay attention, something is about to happen. It stays on the screen for approximately two seconds and then it is followed by a word triad slide. (Slide changes) That is a slide which has three words on it, as you can see. In this case the words are flower, horse, and big. As soon as you see a word triad slide say the words out loud immediately. For example, this slide would appear and you would say flower, horse, big. The word triad slide stays on the screen for approximately two seconds, and chances are that by the time you have finished saying the words the slide will be gone. (Slide changes) It will be replaced by a number slide, such as this. As soon as the number slide appears you say the number out loud, and then you begin to count backwards by threes from the number as rapidly as you can and making as few mistakes as you can. For example when this slide appears you will say "173, 170, 167, 164, 161" and so on, as quickly as you can without making mistakes. If you do make a mistake just carry on counting backwards by threes from your mistake. As soon as we have

finished looking at the rest of the slides we'll come back and give you a chance to practice counting backwards by threes before we begin the experiment, and this slide lasts for approximately 15 seconds. As soon as the number slide disappears you will see a question mark (Slide changes) like this. The question mark means please say out loud any of the words which you recall from the word triad slide which you saw before you started counting. Be sure to call them out nice and loudly. In this case, for example, you would say flower, horse, and big. The question mark slide stays on the screen for ten seconds. After that you will see a blank slide like this. (Slide changes) This is a rest slide. It means, relax, sit back, maybe take a deep breath. The point of the rest slide which stays on the screen for six seconds is to give you a chance to rest before the whole sequence starts over again. This sequence of slides reoccurs four times, and that's the end of the first experiment. Of course, you see different words and numbers on each sequence of slides. As you can see, this first experiment is very short, but it requires that you pay careful attention. Now, to give you a better idea of how the timing works I'll run through one practice sequence to show you what it's like. Please pay careful attention to how I do it because this is exactly what you will be doing. (The experimenter then demonstrated one sequence using the words flower, horse, and big and the distractor number 934.)

That should explain to you how the experiment works. The most likely place for you to find difficulty is in counting backwards by

Appendix H

threes. In a moment a number will appear on the screen. As soon as it does I'd like you to begin counting out loud, backwards by threes, just as you saw me do it in the demonstration sequence. Fill the whole room with your voice. (A sequence of numbers, with appropriate rest breaks, was then presented. The practice sequence was stopped when a stable rate of counting backwards had been achieved. The instructions were resumed.)

O.K., you can stop counting now, that was very good. I think you have a good idea of what takes place in the experiment now. To make sure, will you see if you can tell me the order in which the slides will appear and what you will try to do as you see each slide. Afterwards, if you have any questions, please feel free to ask. I'll do my best to answer them if I can.

# Appendix I

## The LTM Instructions

Thank you for having taken part in the first experiment. If you are like most people you probably noticed that you experienced quite an emotional impact during the first experiment particularly if you made a couple of mistakes or if you had difficulty counting backwards by threes. At least an emotional impact is not unusual. We decided that it would be worthwhile to study just that emotional impact; the type of thing that happens when people take part in typical memory or psychological experiments. Unfortunately, I can't go into more detail than that, because doing so would probably prejudice the results. What I can do is tell you how we intend to study it. First of all we have to wait 24 hours or very close to 24 hours. To do that I've prepared a questionnaire which is in the envelope you have just been given. On the envelope is written the date and the time you are to open it. But before you open it, please be ready with a pen. Then, sit down, open the envelope, answer the questionnaire, put it in the self-addressed envelope that is attached to it, and seal it up. It is very important that you do it exactly that way. Once again, wait 24 hours, open the envelope, answer the questionnaire, seal the thing up, and then you are all finished. It is vital to our research that you do it just that way.

As soon as I receive your results I'll mail out your dollar. Once again, thank you very much for having participated in both of our experiments.

# Appendix J

*Instructions*

The purpose of this study is to measure the *meanings* of certain things to various people by having them judge them against a series of descriptive scales. In taking this test, please make your judgments on the basis of what these things mean *to* you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.

Here is how you are to use these scales:

If you feel that the concept at the top of the page is *very closely related* to one end of the scale, you should place your check-mark as follows:

fair _X_:____:____:____:____:____:____ unfair

or

fair ____:____:____:____:____:____:_X_ unfair

If you feel that the concept is *quite closely related* to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

strong ____:_X_:____:____:____:____:____ weak

or

strong ____:____:____:____:____:_X_:____ weak

If the concept seems *only slightly related* to one side as opposed to the other side (but is not really neutral), then you should check as follows:

active ____:____:_X_:____:____:____:____ passive

or

active ____:____:____:____:_X_:____:____ passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

If you consider the concept to be *neutral* on the scale, both sides of the scale *equally associated* with the concept, or if the scale is *completely irrelevant*, unrelated to the concept, then you should place your check-mark in the middle space:

safe ____:____:____:_X_:____:____:____ dangerous

IMPORTANT: (1) Place your check-marks *in the middle of spaces*, not on the boundaries:

THIS NOT THIS

____:____:____:_X_:_X___:____

(2) Be sure you check every scale for every concept — *do not omit any*.

(3) Never put more than one check-mark on a single scale.

Sometimes you may feel as though you've had the same item before on the test. This will not be the case, so *do not look back and forth* through the items. Do not try to remember how you checked similar items earlier in the test. *Make each item a separate and independent judgment*. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impressions.